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Mary Douglas Frankland
Brighton. 1852.

THE
DISCRIMINATION OF MINERALS
BY
CHEMICAL TESTS.



INSTRUCTIONS

FOR THE

DISCRIMINATION OF MINERALS

BY

SIMPLE CHEMICAL EXPERIMENTS.

BY

FRANZ VON KOBELL,

PROFESSOR OF MINERALOGY IN THE UNIVERSITY OF MUNICH.

TRANSLATED FROM THE GERMAN,

BY ROBERT CORBET CAMPBELL.



GLASGOW:

PUBLISHED BY RICHARD GRIFFIN & COMPANY,
AND THOMAS TEGG, LONDON.

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MDCCXXII.



ADVERTISEMENT.

THE object and use of this work are so fully explained in the Author's "INTRODUCTION," that it is needless for the Editor to expatiate either on the merits of the subject, or the manner in which it is treated. He believes that the work will prove no unwelcome addition to British scientific literature, and he indulges in the hope that the translation will be found to do justice to the original.

The greater part of the work was prepared for publication by the late ROBERT CORBET CAMPBELL, a zealous and talented young chemist of this city. When nearly ready for the press, its progress was stopped by a severe illness which attacked the Translator, and which, after a few weeks continuance, terminated fatally, to the regret of the numerous friends whom MR. CAMPBELL'S scientific acquirements and amiable character had attached to him.

The manuscript left unfinished by the Translator, has been carefully compared with the original, and such corrections and additions have been made, as were necessary to render the work complete. The text is almost a literal translation of Professor VON KOBELL'S text, except as regards the alteration of the chemical symbols, explained at page xi of the "Introduction." Where any thing is added, it is placed within brackets []. The only additions that require particular notice, are those which exhibit the new method of *expressing the CLEAVAGE of minerals by symbols*, described in J. J. GRIFFIN'S recently published "*System of Crystallography*."

The "Introduction" is a paraphrase of the Prefaces prefixed to the Second and Third Editions of the German work. It comprises the whole matter of those two documents, re-arranged and condensed, deprived of a few unimportant sentences, and altered by one or two explanatory interpolations. It is hoped that these corrections will meet the approval both of the author and the public.

That part of MR. GRIFFIN'S "*System of Crystallography*," which contains the "Application of Crystallography to Mineralogy," will be found to form, in conjunction with the present work, a useful Manual of Practical Mineralogy.

EDITOR OF THE SCIENTIFIC MISCELLANY.

GLASGOW, 20th February, 1841.

1

INTRODUCTION.

THE object of the following work is to facilitate the DISCRIMINATION OF MINERALS. For this purpose, simple and easy experiments, performed with Chemical Tests or the Blowpipe, are employed to develop certain properties, which serve to separate the minerals into a number of groups, each containing but a few dissimilar species. A second set of chemical experiments is then employed, conjointly with the more striking physical characters of the minerals, to distinguish the individual species belonging to each group from one another.

The examination of a mineral, conducted on this plan, furnishes the observer with a pretty trustworthy indication of the name of the specimen submitted to trial. He is thus enabled to refer to a System of Mineralogy, and, on comparing the characters of his specimen with those registered in the book, he either finds a confirmation of the correctness of his results, or is supplied with such additional information, as leads him, by short steps, to the true solution of his problem.

Of the advantages which attend this method of procedure, I have been furnished with satisfactory experience, in the course of several years, during which it has been employed by the students of Mineralogy in this University. The method will also be found useful to persons who, though not devoted to the study of Mineralogy, have yet frequent occasion to ascertain the names of minerals which accident or business places before them: I allude to chemists, miners, technologists, and naturalists; to whom, I hope, this little production will not prove unwelcome.

It is naturally taken for granted, that the reader is acquainted with the use of the blowpipe, and with the mode of performing the simpler kinds of analytical operations; such as solution, filtration, and precipitation. Details on these points must be sought for in works which treat expressly on Manipulation. In regard to the blowpipe, we have, in the admirable work published by BERZELIUS, every kind of information which the analyst can require.*

* [See also CHEMICAL RECREATIONS, by J. J. GRIFFIN, Eighth Edition, Part First, containing the subjects of *Chemical Manipulation*, and *Analysis by the Blowpipe*, 12mo, Glasgow, 1838. This work contains an account of the apparatus employed in Chemical Analysis, and of the precautions necessary to be taken to ensure success in using it.]

The principal classification in the following work, is founded on one of the most striking and obvious of the external characters of minerals, namely, the possession of a *metallic* or *non-metallic lustre*. In doubtful cases, I have placed in the former class, only such minerals as are also perfectly opaque; which arrangement appears to obviate every difficulty that might possibly arise during the examination of minerals that possess an adamantine or pseudo-metallic mother-of-pearl lustre. However, it requires but a couple of blowpipe experiments, and a trial of solubility in muriatic acid, to enable one in such cases to determine the name or place of a mineral without reference to its lustre at all. Thus, if you compare with one another the characters of the subordinate groups, you will find that a mineral belonging to one group, is not easily referable to another. Take *Lievrite* as an example of a case in which you doubt whether the substance has a metallic or a non-metallic lustre. You examine its properties experimentally, and find that it fuses to a magnetic bead without fuming, that it gives no sulphuret with soda, and that it gelatinises with muriatic acid. These characters, without further examination, show that the mineral does not come under any of the sections in Class 1, and that it agrees entirely with the characters of Class 2, Section B 5. c.). Nevertheless, as *Lievrite* possesses a pseudo-metallic greasy lustre, and is opaque, it is also placed in the system among the minerals with metallic lustre, in Class 1, where, under A 6, there is a reference to *Lievrite* at its right place.

The examination of the *fusibility of minerals* must not only be tried upon charcoal, but also in the platinum tongs, and when the minerals are difficult of fusion, very thin pointed splinters are to be taken for trial. If a small round block of a mineral is submitted to the blowpipe flame, it may appear to be entirely infusible; when, if a fine splinter were taken and heated in the same flame, it would be pronounced fusible.

As experience has shown me that beginners easily mistake degrees of fusibility in minerals, I have been induced to propose, for their guidance, the following

SCALE OF FUSIBILITY BEFORE THE BLOWPIPE.

- | | |
|--------------------|----------------------------------|
| | 1. SULPHURET OF ANTIMONY. |
| <i>Walt's 1000</i> | 2. NATROLITE. |
| <i>Argent</i> | 3. ALMANDINE. (Thoneisengranat.) |
| <i>Kornblende</i> | 4. STRAHLSTEIN. |
| <i>Feldspat</i> | 5. ADULARIA. |
| | 6. DIALLAGE. (Bronzite.) |

All minerals which are distinctly fusible, fall within the first five degrees of this scale. Those whose degree of fusibility brings them between 5 and 6 of the scale, may be considered infusible, either when the pieces submitted to trial are not sufficiently slender, or when the

Assayer is not perfectly master of the blowpipe. One great advantage of this scale of fusibility is, that it facilitates the highly useful practice of *comparative experiment*. Two persons operating on the same mineral may sometimes differ as to its degree of fusibility; but when a person tries the fusibility of an unknown mineral against another mineral whose fusibility is well ascertained, he has the advantage of a fixed point of comparison, which acts as a check upon erroneous experiments, that might otherwise lead to false conclusions. The minerals selected for this scale belong to those which can be procured without much difficulty. The analyst should be provided with a quantity of each, split into pieces of different sizes and shapes, from which to select such as closely agree in form with the pieces of the unknown minerals that are to be submitted to comparative experiment. This preliminary comparison of the form of two assays that are to be submitted to comparative fusion, is the more necessary, since, at the best, the determination of the degree of fusibility of a mineral, can only be considered as approximate to exactness.*

As I have endeavoured, throughout this work, to render the correct discrimination of a mineral as independent as possible of all errors of observation, I have guarded against any mistaking of fusible for infusible minerals, by placing such as are of difficult fusibility in both classes, so that a mistaken judgment on that point cannot lead to the overlooking of the puzzling substance. The experimenter is, however, particularly requested to observe, that, in the examination of every mineral, he must commence by a comparison of its characters with those of the classes and orders which occur at the beginning of the book, and so proceed regularly on, without skipping any, till he comes to the one of which he is in search. This procedure cannot safely be altered or reversed; for many minerals which belong to an early group also manifest the characters of a subsequent group; whereas the minerals of the later groups do not show the characters of the groups that precede them.

In order to observe whether or not a mineral colours the blowpipe flame, it is necessary to produce a small and very clear blue flame,† because a large ragged yellow flame overpowers some of the more delicate tinges of colour.

The DEGREE OF HARDNESS of the minerals, is denoted according to the scale of MOHS, which contains the following degrees:—

* [Messrs. R. GRIFFIN & Co., Glasgow, supply a small cabinet containing a collection of the minerals which form VON KOBELL'S DEGREES OF FUSIBILITY, at the price of 5s.]

† [On the subject of "*Coloured Blowpipe Flames*," consult GRIFFIN'S *Chemical Recreations*, Part First, page 148.]

MOHS'S SCALE OF HARDNESS.*

1. TALC.	6. ADULARIA.
2. GYPSUM.	7. ROCK CRYSTAL.
3. CALC SPAR.	8. TOPAS.
4. FLUOR SPAR.	9. CORUNDUM. <i>ll = 13. 14</i>
5. APATITE.	10. DIAMOND.

To determine the presence of water in a mineral, it is proper to take a small crystal, or a compact piece, of the size of half a pea, and to heat it before the blowpipe, or over a spirit lamp, in a small glass tube closed at one end, or in a narrow glass tube, $\frac{1}{4}$ inch wide, open at both ends, and held in the flame horizontally. In the latter case, the water gathers in drops in the cold part of the tube, on both sides of the assay.

When solution in an acid is to be effected, the assay is pulverised extremely fine in an agate mortar, water is added and ground with the mineral, and the fine powder is gradually decanted off with the water. The action of a diluted acid is first tried, and if without success, then a concentrated acid is employed. The best vessel to use is a small flask, or else a glass tube, one inch wide and seven inches long, which can be heated over a spirit lamp.

The general remark may not be useless here, that all minerals which are as hard as quartz, with the exception of chrysolite, some garnets, and a few other minerals, are not decomposable by muriatic acid, without previous fusion with an alkali.

Instead of entering into further details respecting the following work, I shall give an example or two to show the way to use it.

First Example. ALUMINITE.

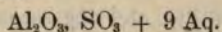
This mineral has a non-metallic lustre. It is infusible. Hence it belongs to Class 2, Order C. The characters of the first Section of this Order, C 1, depend upon the colour which the mineral assumes, when heated before the blowpipe with solution of cobalt. On making this trial, the mineral is found to belong to Section C 1. This Section contains two divisions, *a.*) and *b.*), depending upon the presence or absence of water in the mineral. You make the necessary experiment, by heating the assay in a glass tube, and find that it gives much water: it therefore belongs to division *a.*) You now refer, from the table of *Classification*, to page 36 of the text, where the minerals of C 1 *a.*) are described. The first group of this division contains *Alum-stone* and *Aluminite*, and the distinctive character given for them is, that, with soda on charcoal, they give sulphurets, which is not the case with the

* [Messrs. R. GRIFFIN & Co., Glasgow, supply small cabinets containing the minerals constituting MOHS'S DEGREES OF HARDNESS, (Diamond excepted), with a proper file for making the trials, at the price of 16s.

Instructions for examining the degrees of hardness of minerals, with suitable precautions, are given in GRIFFIN'S "*System of Crystallography*," Part Second, page 96.]

rest of the minerals belonging to the same division. On making this experiment, the *Aluminite*, of course, gives a sulphuret, and is thus found to be either *Alum-stone* or *Aluminite*. Next it is recorded of these two minerals, that the latter is easily soluble in muriatic acid, and the former not so. An experiment with muriatic acid, therefore, determines the mineral to be *Aluminite*.

With a view to afford the experienced chemist a ready means of testing more closely the characters of the different minerals, I have added to each its chemical or mineralogical formula.* Thus, *Aluminite* is accompanied by the symbol



which shows that the constituents of this mineral are alumina, sulphuric acid, and water; the detection of each of which substances can be made the object of a separate experiment, based on the common rules of chemical analysis.

* [The Editor has taken great liberties with these formulæ, chiefly because it was impossible to print them *verbatim* without having type cast expressly for the purpose. He has, therefore, in many cases, merely given the symbols that represent the ultimate elements of the minerals, which, however, are not only quite sufficient to guide the analyst in his experiments, but also serve to explain the nomenclature and synonyms of the minerals. The following Table will afford some additional information:—

CHEMICAL SYMBOLS EXPLAINED.

Ag. Silver	1352.	H. Hydrogen	6½.	S. Sulphur	201.
Al. Aluminum	171.	Hg. Mercury	1266.	Sb. Antimony	806.
As. Arsenic	470.	I. Iodine	789.	Se. Selenium.....	495.
Au. Gold.....	1243.	Ir. Iridium	1233.	Si. Silicium	277.
B. Boron	136.	K. Potassium	490.	Sr. Strontium	547.
Ba. Barium	857.	L. Lithium.....	81.	Sn. Tin	735.
Be. Glucinum	331.	Mg. Magnesium	158.	Ta. Tantalum	1154.
Bi. Bismuth	887.	Mn. Manganese	346.	Te. Tellurium	802.
Br. Bromine	489.	Mo. Molybdenum	599.	Th. Thorium	745.
C. Carbon.....	76.	N. Nitrogen	89.	Ti. Titanium	304.
Ca. Calcium	256.	Na. Sodium	291.	U. Uranium	2711.
Cd. Cadmium.....	697.	Ni. Nickel	370.	V. Vanadium	856.
Ce. Cerium.....	575.	O. Oxygen	100.	W. Tungstenum	1183.
Cl. Chlorine	221.	Os. Osmium	1244.	Y. Yttrium	402.
Co. Cobalt	369.	P. Phosphorus.....	196.	Zn. Zinc.....	403.
Cr. or Ch. Chromium...	352.	Pb. Lead	1294.	Zr. Zirconium	420.
Cu. Copper.....	396.	Pd. Palladium	666.		
F. Fluorine	117.	Pt. Platinum.....	1233.	Aq. Water	112½.
Fe. Iron	339.	R. Rhodium	651.		

To find the comparative quantities of the chemical elements which constitute any given mineral, multiply the numbers quoted in the above table, by the small figures or exponents which follow the symbols in the body of the work. Where there are no exponents, the symbols express the quality but not the quantity of the constituents, except in the case of the simpler compounds, where the absence of an exponent sometimes implies unity. Thus, Ag S is Ag₁S₁. The atomic weights are those of Berzelius.

Example: RED OXIDE OF COPPER = Cu₂O, page 22.

$$\text{Cu} = 396 \times 2 = 792 = \text{Copper.}$$

$$\text{O} = 100 \times 1 = 100 = \text{Oxygen.}$$

$$\underline{\hspace{1.5cm}} \\ 892 = \text{Red Oxide of Copper.}]$$

Second Example. PURPLE COPPER.

This mineral has a metallic lustre. It fuses before the blowpipe without smoking, but when heated in the oxidating flame, it produces the odour of sulphurous acid. It follows thence, that it belongs to Class 1, Order A, Division 5. It belongs to this division, because a mineral which produces sulphurous acid when heated alone in the oxidating flame, produces a sulphuret when heated with soda in the reducing flame. Arrived at this result, you are referred, by the table of CLASSIFICATION, to page 11 of the text, where the minerals belonging to Class 1, A 5, are detailed. The first mineral of this division = Ag S, is distinguished by its sectility, and the second = Mn S, by its colour and streak. You then come to a group which contains the given subject of assay, in company with many related minerals. The character of the group, with one exception, is, that the partial solution in nitric acid, gives with an excess of caustic ammonia, an azure-blue solution, and that when the mineral, after fusion on charcoal, is moistened with muriatic acid, it colours the blowpipe flame beautifully blue. Your mineral shows these properties, and is, therefore, a member of the given group, while its colour is alone sufficient to distinguish it from all the other members of the same group.—It happens, that the colour of most of the minerals which possess a metallic lustre, is a trustworthy character, for which reason I have commonly mentioned it, and sometimes with the advantage of being thereby enabled to dispense with the recital of several other characters.

I have invariably endeavoured to found the different divisions, not only upon *clear* and *decisive* characters, but also upon such as can be *easily* and *quickly developed*. I have not laboured to adduce a multitude of characters, but have restricted myself to those which are most exact. I refer to my "*Charakteristik der Mineralien*," for a more extensive enumeration of confirmatory characters of the minerals.

Wherever there appeared to be a possibility of mistaking one mineral for another, I have added notes to warn the experimenter of his danger, and of the way to avoid it. It scarcely requires to be noticed, that the analyst can expect *distinct reactions* in his experiments, only when he employs *pure materials*. Many specimens of *Wollastonite* effervesce with acid, or after ignition, react alkaline; yet these reactions are not the characteristics of pure *Wollastonite*, but depend upon an intermixture of *Calcareous Spar*. Hence, if the analyst finds occasion to believe that he has an impure mineral to examine, he must consider the nature and properties of the matrix, or other accompaniment of his mineral, and must judge of the results of his experiments with reference to the possible effects of that accompaniment.

The work embraces pretty well every mineral whose chemical characters have been satisfactorily ascertained.

MUNICH, { *January*, 1835.
 { *March*, 1838.

CLASSIFICATION.

CLASS I. Minerals with Metallic Lustre.

CLASS II. Minerals with Non-Metallic Lustre.

The Minerals whose lustre is IMPERFECT *Metallic* are placed in the first class when completely opaque, and in the second class when translucent on the edges.

Each of the Two Classes is divided into Three Orders.

CLASS I. MINERALS WITH METALLIC LUSTRE.

- O. Metals, distinguishable by their physical properties.
 - A. Fusible, 1—5, or else readily volatile.
 - B. Infusible, or fusibility above 5, and non-volatile.
- } Page 2.
-

CLASS II. MINERALS WITH NON-METALLIC LUSTRE.

- A. * BB, easily volatile or combustible.
 - B. BB, fusible, 1—5, but not, or only partially, volatile.
 - C. BB, infusible, or fusibility exceeding 5.
- } Page 3.
Page 4.

* BB, signifies *Before the Blowpipe*.

CLASS I.

MINERALS WITH METALLIC LUSTRE.

O. NATIVE METALS

EASILY DISTINGUISHED BY THEIR PHYSICAL PROPERTIES, Page 5.

A. FUSIBLE, 1—5, OR ELSE READILY VOLATILE,

1. BB, on charcoal, give a strong odour of arsenic, p. 6.
 2. BB, on charcoal, or in an open glass tube, give the horse-radish odour peculiar to Selenium, p. 7.
 3. BB, in an open glass tube, give a white or grey sublimate, which runs into colourless transparent drops when again exposed to heat, p. 8.
 4. BB, on charcoal, disengage a thick antimonial vapour, p. 9.
 5. BB, with soda, give a sulphuret, but without manifesting the general properties of the minerals of the preceding sections, p. 11.
 6. BB, behave differently from the minerals in the preceding five sections, p. 13.
-

B. INFUSIBLE, OR FUSIBILITY ABOVE 5. NON-VOLATILE.

1. BB, with borax, in the oxidating flame,—a very small quantity gives the borax an amethyst-red colour, p. 14.
2. BB, on charcoal in the reducing flame,—when the blast has been sustained a long time, the assay becomes magnetic, p. 15.
3. Partially agreeing with the last section, p. 16.

CLASS II.

MINERALS WITH NON-METALLIC LUSTRE.

ORDER A and ORDER B.

A. BB, EASILY VOLATILE OR COMBUSTIBLE, p. 17.

B. BB, FUSIBLE, 1—5, BUT NOT ENTIRELY VOLATILE.

1.) BB, ALONE, OR WITH SODA ON CHARCOAL, GIVE A METALLIC BEAD, OR A MAGNETIC METALLIC MASS.

1. BB, Alone, or with soda, give a bead of silver, p. 18.
2. BB, Alone, or with soda, give a bead of lead, p. 19.
3. BB, Alone, or with soda, give a bead of copper, When fused, and then moistened with muriatic acid, colour the flame beautifully but transiently blue.
 - a.) BB, on charcoal, give a strong odour of arsenic, p. 21.
 - b.) BB, on charcoal, give *no* odour of arsenic, p. 22.
4. BB, with borax, give a fine sapphire-blue colour, p. 23.
5. BB, Fused in the reducing flame, in the forceps, or on charcoal, give a black or grey magnetic mass; but without showing the properties of the minerals of the preceding four sections.
 - a.) During fusion, give a strong odour of arsenic, p. 23.
 - b.) Dissolve in muriatic acid, without a sensible residue, and produce no jelly, p. 24.
 - c.) Dissolve in muriatic acid, under production of a gelatinous precipitate of silica, p. 25.
 - d.) Very little acted on by muriatic acid, p. 25.
6. Not belonging to the preceding five sections, p. 26.
 - 2.) BB, ALONE, OR ON CHARCOAL WITH SODA, GIVE NO METALLIC BEAD, AND NO MAGNETIC METALLIC MASS.
7. BB, After fusion and strong ignition, on charcoal, or in the forceps, or the platinum spoon, react alkaline, communicating a reddish-brown colour to moistened turmeric paper.
 - a.) Easily and entirely soluble in water, p. 26.
 - b.) Nearly or entirely insoluble in water, p. 27.
8. Soluble in muriatic acid, and some of them in water, without leaving a residuum, and without producing a jelly, p. 28.
9. Soluble in muriatic acid, producing a thick and perfect jelly.
 - a.) BB, in the matrass, give much water, p. 29.
 - b.) BB, in the matrass, give *no* water, or only traces, p. 30.
10. Soluble in muriatic acid, leaving a residuum of silica, but not producing a perfect jelly.
 - a.) BB, in the matrass, give much water, p. 31.
 - b.) BB, in the matrass, give *no* water, or only traces, p. 32.
11. Very little acted on by muriatic acid. BB, with borax, give the violet colour that indicates manganese, p. 33.
12. Not included in the preceding five sections, and, with one exception, consisting of silicates, that are either not at all, or only imperfectly decomposable, by muriatic acid, p. 33.

CLASS II.
MINERALS WITH NON-METALLIC LUSTRE.

ORDER C.

C. BB, INFUSIBLE, OR FUSIBILITY EXCEEDING 5.

1. Previously ignited, BB, then moistened with solution of cobalt and again ignited, acquire a beautiful blue colour.
 - a.) BB, in the matrass, give much water, p. 36.
 - b.) BB, in the matrass, give little or *no* water, p. 37.
2. Moistened with solution of cobalt, and ignited, BB, acquire a green colour, p. 38.
3. After ignition, BB, react alkaline, and give a reddish-brown colour to moistened turmeric paper, p. 39.
4. Entirely, or for the most part, soluble in muriatic or nitric acid, without producing a jelly or leaving any considerable residuum of silica, p. 40.
5. Soluble in muriatic acid, producing a jelly, or else depositing silica without producing a jelly.
 - a.) BB, in the matrass, give much water, p. 42.
 - b.) BB, in the matrass, give *no* water, or only traces, p. 43.
6. Not included in the preceding five orders. Divided thus:
 - a.) Hardness under 7, p. 43.
 - b.) Hardness = 7 or above 7, p. 45.



CLASS I.

MINERALS WITH METALLIC LUSTRE.

Of the minerals which possess an IMPERFECT metallic lustre only such are included in this division as are at the same time opaque; as for example, Wolfram and Chrome Iron Ore.

O. NATIVE METALS

EASILY DISTINGUISHED BY THEIR PHYSICAL PROPERTIES.

Native Mercury, Hg. Gediegen Quecksilber.

Liquid at common temperatures; of a tin-white colour.

Native Silver, Ag. Gediegen Silber.

Silver-white, perfectly malleable, easily soluble in nitric acid; the solution treated with muriatic acid gives a curdly-white precipitate, which rapidly changes colour when exposed to the light, becoming first grey, and then black. H. 2, 5.

Native Gold, Au. Gediegen Gold.

Argentiferous Gold. Ag + Au. Electrum. Goldsilber.

Possess more or less a golden-yellow colour, and are perfectly malleable. *Native Gold* dissolves only in aqua regia (nitric and muriatic acids mixed together), and leaves scarcely any residue. *Argentiferous Gold* is wholly or partially decomposed by aqua regia, under separation of chloride of silver. The solutions of both give, with protosulphate of iron, a reddish-brown precipitate of gold, to which friction communicates a metallic lustre, and the yellow colour of gold.

Native Copper, Cu. Gediegen Kupfer.

Of copper-red colour, ductile and malleable; soluble in nitric acid, giving an azure-blue solution.

Native Lead, Pb. Gediegen Blei.

Of lead-grey colour, ductile and malleable; BB, easily fusible; smokes and deposits upon the charcoal a greenish-yellow sublimate. Soluble in diluted nitric acid; the solution affords, with sulphuric acid, an abundant white precipitate. H. 1, 5.

Native Platinum, Pt. Gediegen Platin.

Palladium, Pd.

Both ductile and malleable; both infusible. *Platinum* is of a steel-grey colour, not soluble in nitric acid, but dissolves when digested in aqua regia. *Palladium* possesses a colour between steel-grey and silver-white, is dissolved by nitric acid, but more easily by aqua regia. The solution of *Platinum* gives, with carbonate of potash, a yellow precipitate, insoluble in excess; that of *Palladium* gives, with carbonate of potash, a brownish precipitate, soluble in excess.

Native Iron, Fe. Gediegen Eisen.

Ductile and malleable; light steel-grey; attracted by the magnet; infusible; easily soluble in muriatic acid.

A. FUSIBLE, 1-5, OR EASILY VOLATILISED.

A 1. BB, on Charcoal, produce a strong odour of Arsenic.

Native Arsenic = As. Gediegen Arsenik.

Arsenic Glance = As. Arsenikglanz.

BB, volatilise without fusing; sublime in a bulb tube as a metallic greyish-white crystalline crust. *Arsenic Glance*, BB, takes fire, and continues to burn without a continuance of the blast; gives a grey arsenical smoke, and becomes covered with crystals of arsenious acid.

Native Arsenic ceases to burn on being taken from the blowpipe flame.

Arsenical Grey Copper = Fe Zn Cu Sb As S_x. Arsenikfablerz.

Polybasite = Cu Ag Sb As S_x.

BB, on charcoal, fused and then moistened with muriatic acid, they communicate to the flame a beautiful blue colour. *Polybasite* gives, with soda and borax, a button of silver, which by fusion with borax may be procured quite free from copper. *Grey Copper*, treated in this way, gives with great difficulty a button of copper only. The copper is more easily extracted by fusing the mineral with lead and boracic acid. The partial solution of *Grey Copper* in nitric acid gives, with muriatic acid, little or no precipitate; the solution of *Polybasite* gives an abundant precipitate of chloride of silver. Both the minerals yield sulphuret of arsenic and sulphuret of antimony, to a solution of caustic potash; and on the addition of muriatic acid to the solution, these substances are precipitated in lemon-yellow flocks. (When the sulphuret of antimony is in excess, the flocks are yellowish red). *Grey Copper* has a steel-

grey colour. *Polybasite*, an iron-black colour. The hardness of the first is 3.5, that of the last 2.5.

Tin-White Cobalt = Co As_2 . Speisskobalt.

Bright-White Cobalt = $\text{Co As}_2 + \text{Co S}_2$. Glanzkobalt.

BB, communicate to borax a beautiful sapphire-blue colour, although present in very minute quantity; they are dissolved by concentrated nitric acid under separation of arsenious acid. The solution generally possesses a rose-red colour. Silicate of potash, added to a much diluted solution, gives it a sky-blue colour, or produces a blue precipitate. Chloride of barium produces in the solution of *Bright-white Cobalt* an abundant white precipitate, in that of *Tin-white Cobalt* no precipitate, or only a very slight one. The colour of *Tin-white Cobalt* is from tin-white to light steel-grey; that of *Bright-white Cobalt* is reddish silver-white.

Compare with the following substances:—

Red Arsenical Nickel = Ni As . Rothnickelkies.

White Arsenical Nickel = Ni As_2 . Weissnickelkies.

Nickel Glance = $\text{Ni S}_2 + \text{Ni As}_2$. Nickelarsenikglanz.

Give with nitric acid an apple-green solution. By adding to this a solution of chloride of lime till a precipitate begins to be formed, and then caustic ammonia in excess, a sapphire-blue solution is obtained. Caustic potash and silicate of potash produce in the nitric acid solution greenish precipitates. Chloride of barium produces an abundant precipitate in the solution of *Nickel Glance*, but none in the solutions of the two other minerals. All three substances commonly afford indications of cobalt before the blowpipe. The colour of *Red Arsenical Nickel* is light copper-red, that of *White Arsenical Nickel* is tin-white, that of *Nickel Glance* light lead-grey, approaching to tin-white.

See Sulpho-Antimonite of Nickel, under A 4.

Arsenical Iron = $\text{Fe S}_2 + \text{Fe As}_2$. Arsenikkies.

BB, in a bulb tube, gives a sublimate of metallic arsenic, and then fuses to a black bead, which, after a long continuance of the blast, becomes magnetic.* It is soluble in nitric acid, under separation of sulphur and arsenious acid. The solution gives with caustic ammonia and potash, a reddish-yellow precipitate. The mineral communicates to borax the green colour which indicates oxide of iron. The fresh fracture is silver-white, somewhat inclining to grey. Sp. gr. 6.2.

See Native Bismuth, A 6, which often contains arsenic.

A 2. BB, on charcoal, or in an open glass tube, exhale the strong odour of horse radish, which distinguishes Selenium.

Seleniuret of Mercury = Hg Se . Selenquecksilber.

Seleniuret of Mercury and Lead = $3 \text{ Pb Se} + \text{Hg Se}$.

Selenquecksilberblei.

* *Autonomous Arsenical Iron* = Fe As_2 . Mispickel, acts in like manner, but after the arsenic is driven off, it fuses with difficulty, and only imperfectly, on the surface. Sp. gr. 7.2.

When heated with soda in the bulb tube, they give metallic mercury. The double seleniuret, heated with soda upon charcoal, gives grains of lead; *Seleniuret of Mercury* gives none. Both vaporize readily; *Seleniuret of Mercury* after fusion, the double *Seleniuret* without fusion. The colour of the first is between steel-grey and dark lead-grey; that of the last is lead-grey.

Seleniuret of Lead = Pb Se. Selenblei.

BB, volatilises almost entirely without fusing, and coats the charcoal at first with a slight metallic grey, and afterwards with a white and greenish-yellow sublimate. With soda it gives grains of lead, but not without difficulty. The solution in nitric acid gives a white precipitate with sulphuric acid. Colour lead-grey.

Seleniuret of Silver = Ag Se. Selsilber.

BB, fusion easy; quiet in the outer flame, but with intumescence in the inner; gives with borax a button of pure silver; dissolves in concentrated nitric acid. The solution, treated with muriatic acid, gives an abundant white precipitate of chloride of silver. Colour iron-black.

Seleniuret of Copper = Cu₂ Se. Selenkupfer.

Seleniuret of Lead and Copper = Pb Se + Cu Se. Selenbleikupfer.

Eukairite = Cu₂ Se + Ag Se. Selenkupfersilber.

All fuse on charcoal to a metallic button, which, moistened with muriatic acid, tinges the flame of a beautiful blue colour. They dissolve in concentrated nitric acid; the solutions, treated with ammonia in excess, acquire an azure blue colour. The solution of *Eukairite* gives, with muriatic acid, a copious precipitate of chloride of silver; that of the *Seleniuret of Lead and Copper* gives, with sulphuric acid, a white precipitate of sulphate of lead; that of the *Seleniuret of Copper* gives no precipitate with these two acids. The colour of the *Seleniuret of Copper* is silver-white, that of *Eukairite* and of the *Seleniuret of Lead and Copper* is lead-grey.

See the following groups.

A 3. BB, in an open glass tube, give a white or greyish sublimate, which melts to colourless, transparent drops, when the tube is heated on the spot where the sublimate is deposited.

By this character are the compounds of tellurium distinguished from those of selenium and antimony. Many of them exhale before the blowpipe an odour of selenium, in consequence of the presence of a small quantity of selenium. The sublimate which they give upon charcoal colours the reducing flame perceptibly green or greenish blue, while that from oxide of antimony gives only a faint bluish tint to the flame.

The ores of tellurium may be divided into two groups, according to the colour :—

a.) *Of a tin or silver-white colour.*

Native Tellurium = Te. Gediegen Tellur.

BB, fuses easily; disappears entirely if long acted on; smokes abundantly, and burns with a greenish flame. It dissolves without residue in nitric acid. The solution affords a white precipitate with caustic potash, which is for the most part soluble in an excess of that reagent. Muriatic and sulphuric acids produce no perceptible precipitate. Colour tin-white to silver-white.

Telluric Silver = Ag Te. Tellursilber.

Telluret of Lead = Pb Te. Tellurblei.

Dissolve in nitric acid without residue. The solution of *Telluric Silver* gives, when excess of nitric acid is present, no precipitate with sulphuric acid; that of *Telluret of Lead* gives an abundant precipitate with the same reagent. The first gives with soda before the blowpipe a button of silver. *Telluric Silver* is malleable, *Telluret of Lead* is soft but not malleable. Colour tin-white.

White Tellurium = Au Pb Ag Te. Weisstellur.

Dissolves for the most part in nitric acid, the gold remaining behind; the solution gives chloride of silver with muriatic acid, and sulphate of lead with sulphuric acid. Colour silver-white inclined to brass-yellow. Brittle.

See the following group.

b.) *Of a lead or steel-grey colour.*

Tetradymite = Bi + Te + S. Tellur-Wismuth.

BB, fuses easily to a silver-white brittle bead of metal. It dissolves with ease in nitric acid under separation of sulphur. The solution gives no precipitate with sulphuric or muriatic acid, but with caustic potash it gives a white precipitate insoluble in excess. Colour light lead-grey. In thin plates, somewhat flexible.

Graphic Tellurium = Ag Te + 3 Au Te₃. Schriftez.

BB, easily fusible; a long-continued blast produces a button of malleable metal. It dissolves imperfectly in nitric acid, and in aqua regia; in the latter, under separation of chloride of silver. The solution gives no precipitate with sulphuric acid. Colour light steel-grey.

Black Tellurium = Pb Te + Au₂ Te₃. Blättererz.

BB, easily fusible; a long-continued blast produces a bead of malleable metal. It dissolves easily and almost entirely in nitric acid. The solution gives, with sulphuric acid, an abundant white precipitate of sulphate of lead. Colour blackish lead-grey.

See Needle Ore, A 5.

A 4. BB, give out a thick smoke of Antimony.

The smoke is almost destitute of odour, or smells only faintly of sulphurous acid, or of arsenic, from the accidental presence of these substances in the ore. On the first application of the heat, it coats the

charcoal with a pure white sublimate, and when the process is conducted in a glass tube, the sublimate may be made to disappear on heating, without melting into drops.

Native Antimony = Sb. Gediegen Antimon.

Grey Antimony = Sb S. Antimonglanz.

Zinkenite = Pb Sb S_x.

Jamesonite = Pb Sb S_x.

Bournonite = Cu Pb Sb S_x.

BB, wholly, or almost wholly, volatile; provided the blast is long sustained.

Native Antimony is distinguished from the others by its tin-white colour. BB strongly heated, it continues to burn for some time after being blown upon, and becomes covered with white needles of oxide of antimony.

See Native Bismuth and Sulphuret of Bismuth.

Grey Antimony in powder speedily assumes an ochre-yellow colour when heated with concentrated caustic potash, and dissolves in it almost entirely. The solution on being tested with muriatic acid, gives yellowish-red flocks. Colour lead-grey to steel-grey.

Zinkenite, *Jamesonite*, and *Bournonite* possess a steel-grey colour. The colour of their powders is not changed when heated in concentrated solution of caustic potash, yet sulphuret of antimony is extracted by that menstruum, and may be precipitated by muriatic acid in orange-coloured flocks.

Zinkenite and *Jamesonite* are oxidated by nitric acid, and afford a white powder, yet very little dissolves, and the acid scarcely acquires any colour. With *Bournonite* a partial solution is obtained of a sky-blue colour, which gives, with sulphuric acid, a white precipitate of sulphate of lead, and produces, with excess of caustic ammonia, an azure blue solution.

Zinkenite is not cleavable; its hardness is 3.5. *Jamesonite* is cleavable in one direction; its hardness is 2.5.

The following minerals resemble those just mentioned, and agree with them perfectly in their chemical actions: *Plagionite* = Pb_x Sb_x S, is pretty perfectly cleavable in the direction of the vertical planes of an oblique prism of 120° 49'. (The prism is M $\frac{1}{2}$ T. $\frac{1}{2}$ P-M Zn. The cleavage = m $\frac{1}{2}$ t. *Griffin*.) Colour blackish lead-grey to iron-black. *Federerz* (capillary sulphuret of antimony) hitherto found only in felt-like interwoven hairy crystals. *Boulangerite* = Pb_x Sb_x S, in fibrous masses of a lead-grey colour.

Antimonial Silver = Ag₂ Sb. Antimonsilber.

Brittle Sulphuret of Silver = Ag Sb S_x. Sprödglasserz.

Argentiferous Grey Copper = Zn Fe Cu Ag Sb S_x. Silberfahlerz.*

Myargyrite = Ag Sb S_x. Hemiprismatic Ruby-Blende.

BB, with soda, or borax and soda, give a malleable button of silver.

* Many specimens of Antimonial Grey Copper, that are poor in silver, belong here likewise. These are distinguished from the rich silver ore by the smaller precipitate afforded by muriatic acid in the solution of the ore in nitric acid.

Antimonial Silver has a silver-white colour, gives no sulphuret with soda, and is not acted on by caustic potash. All the others give a sulphuret with soda, and caustic potash extracts from them sulphuret of antimony, which is precipitated by muriatic acid in orange-coloured flocks. The partial solutions in nitric acid which are obtained from *Brittle Sulphuret of Silver* and *Myargyrite*, acquire only a pale-blue colour on being treated with ammonia, but the solution of the *Argentiferous Grey Copper* acquires a strong azure-blue colour. The colour of *Brittle Sulphuret of Silver* is iron-black to blackish lead-grey; the streak is black. The colour of *Myargyrite* is iron-black to light steel-grey, the streak is dark cherry-red. *Argentiferous Grey Copper* is steel-grey to iron-black; streak, greyish-black. The hardness of *Brittle Sulphuret of Silver* and *Myargyrite* is 2.5, that of *Argentiferous Grey Copper*, 3.5.

See Dark Red Silver.

Sulpho-Antimonite of Nickel = Ni S₂ + Ni Sb₂. Nickelantimon-
Antimonial Nickel = Ni Sb. Antimonnickel. [glanz.
Berthierite = Fe Sb S₂.

BB, give, after long continued fusion upon charcoal, a magnetic bead. Antimonial nickel is difficult to melt: it is little acted on by muriatic acid, but is dissolved easily and completely by nitric acid. Colour light copper-red passing into violet. *Sulpho-Antimonite of Nickel* fuses easily; it is little acted on by muriatic acid, but dissolves in aqua regia under separation of sulphur.* Colour lead-grey to steel-grey. *Berthierite* fuses easily and dissolves readily and completely in muriatic acid under evolution of sulphuretted hydrogen gas. Colour dark steel-grey somewhat inclining to brown.

A 5. BB, with Soda, give a Sulphuret, but without manifesting the general properties of the Minerals of the preceding Sections.

Sulphuret of Silver = Ag S. Glaserz. Silberglanz.

Easily distinguished from the minerals that follow by its malleability and sectility, for it may be cut like lead. BB with soda, it is readily reduced to a button of silver.

Sulphuret of Manganese = Mn S. Manganglanz.

Easily distinguished by its steel-grey colour and leek-green streak. With the fluxes, the indications of manganese are especially distinct. It evolves sulphuretted hydrogen when treated with muriatic acid.

Vitreous Copper (Sulphuret of Copper) = Cu S. Kupferglanz.

Sulphuret of Silver and Copper = Cu S + Ag S. Silberkupferglanz.

Sulphuret of Cop. and Bismuth = Bi S₂ + Cu S. Kupferwismuthertz.

Sulphuret of Tin (Tin Pyrites) = Fe Zn Sn Cu S₂. Zinnkies.

Copper Pyrites = Fe Cu S₂. Kupferkies.

* The reactions of the solutions of Antimonial Nickel, and Sulpho-Antimonite of Nickel, with Ammonia, are given under the article Arsenical Nickel in Section A 1.

Purple Copper (Variegated C.) = Fe Cu S₂. Buntkupfererz.
Needle Ore = Cu Bi Pb S₂. Nadelerz.

Sulphuret of Nickel and Bismuth = Bi Ni S₂. Nickelwismuthglanz.
 Give with nitric acid a partial sky blue or green solution, which acquires an azure blue colour on the addition of caustic ammonia in excess. Fused upon charcoal before the blowpipe, and then moistened with muriatic acid, they colour the flame blue, with the exception of the *Sulphuret of Nickel and Bismuth*, which colours the flame little or none.

The *Copper Pyrites* and *Purple Copper* are easily distinguished by their colour; that of *Copper Pyrites* is brass-yellow, and that of *Purple Copper* varies from copper-red to yellow. Both melt before the blowpipe to a brittle steel-grey bead, which is attracted by the magnet. The colour of the other minerals is grey, which, in the case of the *Sulphuret of Nickel and Bismuth*, approaches to silver-white. In order to distinguish these from one another, the partially-saturated solution in nitric acid is treated consecutively with water and muriatic acid. A precipitate is produced by water in cases where the *Sulphuret of Copper and Bismuth*, the *Sulphuret of Nickel and Bismuth*, and the *Needle Ore* are present; while muriatic acid produces an abundant precipitate of chloride of silver only when the *Sulphuret of Silver and Copper* is under examination. In the acid solution of *Needle Ore*, sulphuric acid produces a precipitate of sulphate of lead, which is not the case with the *Sulphuret of Copper and Bismuth*, or with the *Sulphuret of Nickel and Bismuth*. The former of the two last-mentioned minerals gives, with soda before the blowpipe, a button of copper; the latter, on the contrary, gives a grey button of nickel which is strongly magnetic. The solutions of *Sulphuret of Copper* and *Tin Pyrites* produce no precipitates with the above-mentioned reagents. *Sulphuret of Copper*, BB, on charcoal, gives by itself, when the blast is long-continued, a button of malleable copper, and it is soluble in nitric acid under separation of sulphur. Colour blackish lead-grey to steel-grey. *Tin Pyrites*, BB, by itself, gives no button of malleable metal, and is soluble in nitric acid under separation of sulphur and oxide of tin. Colour steel-grey to brass-yellow.

Sulphuret of Nickel = Ni S. Haarkies.

Sulphuret of Cobalt = Co S. Schwefelkobalt.

Sulphuret of Iron = Fe S. Eisenkies. Iron Pyrites.

Magnetic Iron Pyrites = Fe S₂. Magnetkies.

Sternbergite = Fe Ag S₂.

BB, fuse to a bead which affects the magnet, and which, moistened with muriatic acid, does not perceptibly colour the blowpipe flame. The partial solution in nitric acid is not sky-blue. *Sulphuret of Cobalt* communicates to borax before the blowpipe a sapphire-blue colour. It dissolves easily and perfectly in nitric acid. The solution gives, with silicate of potash, a sapphire-blue, and with chloride of barium, a white precipitate. Colour between tin-white and light steel-grey. *Sternbergite* is partially reduced to silver before the blowpipe. The partial solution

in nitric acid gives, with muriatic acid, an abundant precipitate of chloride of silver. Colour dark tombac-brown. *Sulphuret of Iron* and *Magnetic Iron Pyrites* show before the blowpipe only the reactions of iron and sulphur. *Sulphuret of Iron** does not affect the magnetic needle before being fused, and is only slightly acted on by muriatic acid. Colour yellow. *Magnetic Iron Pyrites* acts on the magnetic needle before being heated, and is almost entirely soluble in muriatic acid under evolution of sulphuretted hydrogen gas. Colour yellow to copper-red, generally with a tombac-brown iridescence. *Sulphuret of Nickel* is very little acted on by nitric acid; but aqua regia produces a green solution in which caustic potash throws down a greenish precipitate. Colour brass-yellow to pale-yellow; as yet only found in hair-like crystals.

Sulphuret of Bismuth = Bi S_2 . Wismuthglanz.

BB, fuses in the reducing flame with boiling and spirting; gives a bead of metallic bismuth, and coats the charcoal with a yellowish sublimate; it is soluble in nitric acid under separation of sulphur; the solution is troubled by dilution with water, giving a white precipitate. Colour light lead-grey to steel-grey.

Galena = Pb S . Bleiglanz.

BB readily reduced to metallic lead, while a greenish-yellow sublimate is deposited upon the charcoal. It is soluble in nitric acid, under separation of sulphur and sulphate of lead. Zinc precipitates metallic lead from this solution. Colour lead-grey.

A 6. *There still remain the following Minerals belonging to division A: Amalgam, Native Bismuth, Wolfram, and Black Silicate of Manganese.*

Amalgam = $\text{Ag} + \text{Hg}$.

BB, in the bulb tube boils and spirts, gives metallic mercury, and leaves a spongy mass of silver; it is easily soluble in nitric acid. Colour silver-white.

Native Bismuth = Bi . Gediegen Wismuth.

Fuses easily; does not continue to burn when taken out of the flame; vaporises by lengthened roasting, and coats the charcoal with a sublimate which is at first white, then in part orange or yellow, becoming somewhat lighter in colour on cooling. In a glass tube it gives almost no smoke, and the metal becomes covered with fused oxide of a dark brown colour, which, on cooling, becomes yellow. By this reaction it is distinguished from native antimony and tellurium. It dissolves readily in nitric acid. Colour reddish silver-white. Not malleable.

* Rhombic Sulphuret of Iron (White Iron Pyrites, or Speer kies) and Tesseral Pyrites are only to be distinguished from one another by means of their crystalline forms. They are both decomposable by nitric acid.

Tungstate of Iron = $Mn Fe W O_6$. Wolfram.

BB, fuses = 3, to a grey, often crystalline, bead. The fine powder boiled with aqua regia, gradually assumes a yellowish colour. The filtered residuum, yet moist, being rubbed upon paper with the blade of a knife, changes its colour from yellow to green, or blueish green. Colour greyish or brownish black to iron-black.

Black Silicate of Manganese = $Mn Si O_3 + Aq$. Schwarzer Mangankiesel

BB, fuses with intumescence, and gives much water in the bulb tube. Communicates to borax in the oxidating flame a deep amethyst-red colour. Soluble in muriatic acid under separation of silica without gelatinizing. Colour lead-grey to iron-black.

Compare Lævrite, Allanite, impure Cinnabar, and Red Copper Ore.

B. INFUSIBLE, OR FUSIBILITY ABOVE 5. NON-VOLATILE.

B 1. BB, with Borax, in the oxidating flame,—a very minute quantity gives the Borax an amethyst-red colour.

The oxides of Manganese belonging to this section are more or less readily soluble in muriatic acid under evolution of chlorine. The solution produces, with caustic potash, a dirty yellowish-white precipitate, which upon the filter becomes speedily yellow, brown, and brownish black. Amongst these minerals, the following are distinguishable by their physical properties:—

Braunite = $Mn_2 O_3$. Brachytypous Manganese Ore.

Dark brownish black. Streak black, a little inclining to brownish. Hardness = 6.5. Gives before the blowpipe little or no trace of water.

Hausmannite = $Mn_3 O_4$. Black Manganese.

Brownish black. Streak chesnut-brown or reddish-brown. Hardness = 5.5. BB in the bulb tube gives no water.

Grey Oxide of Manganese = $Mn_2 O_3 + Aq$. Manganite.

Steel-grey to iron-black. Streak dark reddish-brown. Hardness = 3.5. BB in the bulb tube gives water.

Psilomelane = $Mn O_2 + Ba O + K O$. Compact Manganese Ore.

Blueish or greyish-black. Streak brownish-black to black. Hardness = 5½. BB in the bulb tube gives water. Most varieties, when dissolved in muriatic acid, give, with sulphuric acid, a copious precipitate of sulphate of barytes. (As yet only found amorphous.)

Pyrolusite = $Mn O_2$. Grey Ore of Manganese.

Iron-black to steel-grey. Streak black. Hardness = 2½. BB in the bulb tube gives little or no water.

[The system of crystallisation of braunite and hausmannite is *Pyramidal*; that of grey oxide of manganese and pyrolusite is *Prismatic*.]

B 2. BB, on charcoal in the reducing flame, after being strongly heated, they affect the magnetic needle.

Red Hematite = $\text{Fe}_2 \text{O}_3$. Rotheisenerz.

Distinguished from those that follow by its cherry-red streak, with an iron-black, steel-grey, or brownish-red colour. Slowly soluble in muriatic acid. Not attracted by the magnet.

Franklinite = Mn Fe Zn O_3 . Zinc oxidé ferrifère.

Magnetic Iron Ore = $\text{Fe}_3 \text{O}_4$. Magneteisenerz.

Strongly magnetic. Both slowly dissolve in concentrated muriatic acid. Franklinite under evolution of chlorine gas, magnetic iron ore without it. Franklinite gives with soda in a good reducing flame a faint yellowish sublimate of zinc, magnetic iron ore does not. Both communicate to microcosmic salt in the reducing flame a bottle-green colour, which becomes lighter on cooling. The colour of both is iron-black, the powder of franklinite reddish-brown, of magnetic iron ore black.

Menaccanite = Fe Ti O_3 . Menakan.

Ilmenite = Fe Ti O_3 . Kibdelophan.

Affect the magnetic needle, but are not attracted by the magnet. Both give, with microcosmic salt in the reducing flame, a blood-red glass, which, when saturated, the addition of tin does not render green, nor cause its colour to become pale upon cooling, as happens with magnetic iron ore. The red glass thus heated, either retains its red colour, or changes to violet.* The finely pounded and washed powder of *Menaccanite*, dissolved in concentrated and heated muriatic acid, in a glass flask, gives, with excess of carbonate of lime, a brownish-red precipitate, (peroxide of iron and titanous acid); *Ilmenite*, treated in like manner, gives a white or only slightly-coloured precipitate, (titanous acid). The colour of both minerals is iron-black: *Menaccanite* also occurs steel-grey. Streak black.

Compare Pitch-Blende and Brown Iron Ore, many varieties of which exhibit, on the external or the fractured surface, a pseudometallic lustre.

* Only a very little tin must be added, and the experiment must be conducted upon charcoal. The surest means of recognising these minerals, and other varieties of titanous iron, consists in boiling the fine powder with concentrated muriatic acid, evaporating the solution to a small bulk, then diluting with much water, and again boiling. If titanous acid be present, the solution is troubled, and titanous acid is obtained in the state of a yellowish white precipitate. If but little titanous acid be present, it is detected by first of all converting the peroxide of iron into protoxide, by means of a current of sulphuretted hydrogen gas, warming the solution till the excess of sulphuretted hydrogen be removed, and then adding carbonate of lime in excess. By this means the titanous acid is thrown down, and may be separated from the lime by solution in muriatic acid and precipitation with caustic ammonia.

B 3. *Partially agreeing with the foregoing Minerals.*

Chrome Iron Ore = Al Mg Fe Ch O_x . Chromiesenerz.

Many varieties are strongly magnetic, but many others not so: little acted on by acids; BB, alone, not altered; slowly and perfectly dissolved by borax and microcosmic salt. The beads possess, when cold, a beautiful emerald-green colour. Colour iron-black to pitch-black. Streak yellowish-brown.

Tantalite = Mn Fe Sn Ta W O_x . Columbite.

Ytthro-Tantalite = Ca Y Fe Ta W O_x . Yttertantal.

Little acted on by acids. *Tantalite*, BB, alone, is not altered. *Ytthro-Tantalite* changes its colour to yellowish or white. *Tantalite* is slowly dissolved by borax and microcosmic salt to a glass coloured by iron. *Ytthro-Tantalite* is at first decomposed by microcosmic salt like the silicates. The glass is coloured by iron, (also by Tungsten). Colour iron-black. Streak of *Tantalite* black to brown, of *Ytthro-Tantalite* greyish.*

Sulphuret of Molybdenum = Mo S_x . Molybdänglanz.

Graphite = C. Plumbago. Black Lead.

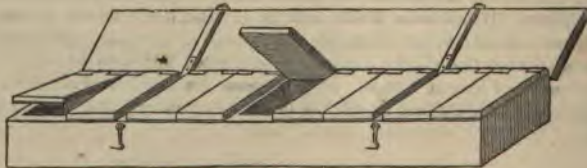
Both very soft: their hardness is 1.5. The colour of *Sulphuret of Molybdenum* is reddish lead-grey, that of *Graphite* is iron-black to steel-grey. *Sulphuret of Molybdenum* held in the forceps, BB, colours the flame light-green, and gives a sulphuret with soda. It is difficultly acted on by borax, and on the addition of a little nitre, it gives, in the outer flame, a colourless or slightly coloured glass, which assumes a brown colour in the inner flame. Heated with nitre in the platinum spoon it deflagrates strongly, with flame. It is difficultly soluble in nitric acid. Graphite shows no such reactions. Many specimens deflagrate with nitre, but not violently.

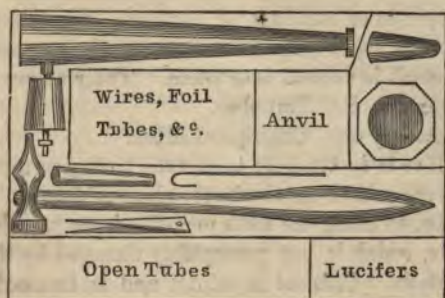
Osmium-Iridium = Ir, Os. Iridosmine.

BB, not perceptibly acted on by borax or microcosmic salt. Fused with nitre in the bulb tube, it exhales the peculiar odour of oxide of osmium. Insoluble in aqua-regia. Colour tin-white to lead-grey. Hard as quartz.

See Pitch-blende.

* It is said that Fergusonite = Y Ce Ta O_x , acts in a similar manner. There are probably several species of Ytthro-Tantalite. Some show no pseudometallic lustre.





CLASS II.

MINERALS WITH NON-METALLIC LUSTRE.

A. BB, EASILY VOLATILE OR COMBUSTIBLE.

Sulphur = S. Schwefel.

BB, burns with a blue flame, and diffuses a strong odour of sulphurous acid. Colour sulphur-yellow to honey-yellow, or when mixed with earthy matters, grey and brown.

Realgar = As S. Sulphuret of Arsenic. Ruby Sulphur.

Orpiment = $As_2 S_3$. Orpiment. Auripigment.

Both fuse very readily, and volatilise with a strong arsenical smoke. Soluble in caustic potash; muriatic acid precipitates from this solution lemon-yellow flocks. *Realgar* has an aurora red, and *Orpiment* a lemon-yellow colour.

Arsenious Acid = $As_2 O_3$. Arsenichte Säure.

BB, with soda in the reducing flame, exhales the odour of arsenic. In the bulb tube gives a crystalline sublimate. Colourless, white.

Oxide of Antimony = $Sb_2 O_3$. Antimonoxyd.

Red Antimony = $Sb_2 O_3 + Sb_2 S_3$. Antimonblende.

Fuse very readily and vaporise, coating the charcoal with a white smoke. *Oxide of Antimony* is soluble in muriatic acid without evolution of gas. *Red Antimony* dissolves almost entirely, under evolution of sulphuretted hydrogen gas. The powder of *Oxide of Antimony* does not change its colour in caustic Potash, that of *Red Antimony* becomes quickly ochre-yellow. *Oxide of Antimony* has a white, *Red Antimony* a cherry-red colour.

Sal Ammoniac. Salmiak. Muriate of Ammonia.

Sulphate of Ammonia. Maskagnin.

Volatilise with a thick smoke; *Sal Ammoniac* without melting, the *Sul-*

phate melting easily and frothing. Both soluble in water. The solution of the *Sulphate of Ammonia* gives, with chloride of barium, an abundant precipitate of sulphate of barytes. *Sal Ammoniac* gives no precipitate with the same reagent. Both exhale an ammoniacal odour when caustic potash is poured over them. Their colour is white.

Cinnabar = Hg S. Zinnober.

Calomel = Hg Cl. Chlorquecksilber.

BB, mixed with soda in the bulb tube, they both give metallic mercury. This is easily recognised, particularly when a feather is run up and down in the tube, to bring the little metallic drops together. *Cinnabar* has a red colour, which is not perceptibly changed by the simple acids and caustic potash. *Calomel* is white, and is immediately coloured black by caustic potash.

See Chloride of Lead.

B. FUSIBLE, 1—5, BUT NOT WHOLLY VOLATILE.

The following minerals, which are at the limits of the degree of heat, No. 5, (between 5 and 6), are introduced in Section C:—Emerald and Euclase, Gehlenite, Cordierite, One-axed and Two-axed Mica, Meerschaum, Carbonate of Iron, and Bergholz.

1.) BB, ALONE, OR WITH SODA ON CHARCOAL, GIVE A BUTTON OF METAL, OR A BEAD WHICH AFFECTS THE MAGNETIC NEEDLE.

All minerals without metallic lustre, which before the blowpipe exhale the odour of arsenic, belong to this section, Pharmacolite excepted.

B 1. BB, alone or with soda, give a button of Silver.

Light Red Silver = Ag₃ As₁ S₃. Arsensilberblende.

Dark Red Silver = Ag₃ Sb₁ S₃. Antimonsilberblende.

Distinguished from the minerals that follow by the red colour of their streak. BB, *Light Red Silver* exhales a strong odour of arsenic, *Dark Red Silver* coats the charcoal with oxide of antimony. The powder of both is immediately blackened when heated with caustic potash, and is partly decomposed. The alkaline solution, on being neutralised by muriatic acid, lets fall, in the case of *Light Red Silver*, lemon-yellow flocks of sulphuret of arsenic, and in the case of *Dark Red Silver*, orange-yellow flocks of sulphuret of antimony. The colour of the former mineral is carmine-red, of the latter, from carmine-red to blackish lead-grey.

See Myargyrite.

Horn Silver = Ag Cl. Chlorsilber.

Iodide of Silver = Ag I. Iodsilber.

BB, upon charcoal, fuse readily and are reduced. *Iodide of Silver*, according to Vauquelin, colours the flame purple-red, *Horn Silver* does not. *Iodide of Silver* communicates to heated muriatic acid a reddish-brown colour, and evolves violet vapours of Iodine. *Horn Silver* shows no such action. Both are insoluble in nitric acid. Their colour is pearl-grey, blueish, brownish, &c. They are malleable.

Carbonate of Silver = Ag O + CO₂. Kohlensaures Silberoxyd.

Easily soluble in nitric acid with effervescence. Colour ash-grey to black. The streak has a metallic lustre.

B 2. BB, alone or with soda, give a button of Lead.

The compounds of lead belonging to this section are soluble in nitric acid. The solution, with zinc, gives metallic lead, and with sulphuric acid, gives an abundant precipitate of sulphate of lead. They dissolve also without residue in caustic potash, (*Vauquelinite* excepted.)

Arseniate of Lead = Pb Cl + 3 (PbO₃ + AsO₅).

Arseniksaures Bleioxyd.

BB, on charcoal, exhales a strong smoke of arsenic, and is reduced. Fused in the forceps in the outer flame it crystallises like phosphate of lead. Colour yellowish-green, brownish.

Hedyphan approaches to the foregoing mineral; its composition is Pb Cl + x (Pb₂O₃ AsO₅ + CaO PO₅). BB, on charcoal, it is partly reduced, and partly gives a white slag, which, after fusion, *per se*, crystallises.

Pyromorphite, = Pb Cl + 3 (Pb₂O₃ PO₅). Phosphate of Lead.

Not reduced when heated by itself upon charcoal, but fuses to a bead, which, upon cooling, assumes a distinctly crystalline appearance. Colour generally green, of different shades, also brown and white.

Red Lead = Pb₂ O₃. Mennig.

Chromate of Lead = PbO, ChO₃ = Chromsaures Bleioxyd.

Melanochroite = Pb₂O₃, Ch₂O₆.

Colour red. *Chromate of Lead* and *Melanochroite*, added in small quantity to borax, communicate to it an emerald-green colour, and dissolve in muriatic acid under separation of chloride of lead, and forming an emerald-green solution.* Red lead gives, with borax, a yellow glass, which becomes colourless on cooling; it communicates no colour to muriatic acid. The streak of *Chromate of Lead* is orange-yellow, that of *Melanochroite* brick-red. The former decrepitates before the blow-pipe, the latter does not.

Chloride of Lead = Pb Cl + Pb O. Mendipite.

Murio-Carbonate of Lead = Pb Cl + PbO, CO₂. Hornblei.

BB, on charcoal, in the reducing flame, are readily reduced. Fused

* When there is a sufficient quantity of muriatic acid, and a sufficiently long digestion.

with a flux of microcosmic salt and oxide of copper, they communicate to the blowpipe flame a beautiful blue colour. They dissolve in nitric acid, the *Muria-carbonate of Lead* with, and the *Chloride of Lead* without, effervescence. The solutions give, with nitrate of silver, abundant precipitates of chloride of silver. Colour white, yellowish, greyish, &c.

White Lead Ore = $\text{Pb O} + \text{C O}_2$. Bleicarbonat.

Sulphato-Carbonate of Lead = $\text{Pb O}, \text{CO}_2 + \text{Pb O}, \text{SO}_3$. Lanarkite.

Sulphate of Lead = $\text{Pb O} + \text{S O}_3$. Bleivitriol.

Sulphato-tri-carbonate of Lead = $\text{Pb O}, \text{C O}_2 + 3 \text{Pb O}, \text{SO}_3$.

Leadhillite.

BB, readily reduced in the reducing flame. *Sulphate of Lead* and *Sulphato-Carbonate of Lead* with soda, give sulphurets. *White Lead Ore* dissolves readily and completely with effervescence in nitric acid; the *Sulphato-Carbonate* dissolves partially with effervescence, and under separation of sulphate of lead; *Sulphate of Lead* dissolves only with great difficulty and without effervescence; *Leadhillite* resembles, in its chemical actions, the *Sulphato-Carbonate*.

Molybdate of Lead = $\text{Pb O} + \text{Mo O}_3$. Molybdänsaures Bleioxyd.

Dissolves in concentrated muriatic acid, under separation of chloride of lead, producing a green solution, which, on being somewhat diluted, and stirred with an iron spatula, acquires a blue colour. When the powder is heated with sulphuric acid in a porcelain basin, and is then mixed with alcohol, the solution, upon cooling, acquires a beautiful blue colour, particularly on the sides of the basin. Colour wax-yellow, honey-yellow, orange-yellow.

Tungstate of Lead = $\text{Pb O} + \text{W O}_3$. Wolframsaures Bleioxyd.

Dissolves in a sufficient quantity of muriatic acid, under separation of a yellowish-green residue of tungstic acid. The solution deposits chloride of lead. The powder becomes beautifully yellow when treated with sulphuric acid. The acid does not acquire a colour. Colour yellowish, yellowish-brown.

Vauquelinite = $\text{Cu Pb Ch}_x \text{O}_x$. Chromate of Lead and Cop.

Vanadate of Lead = $\text{Pb V O}_x + \text{Pb Cl} + \text{Pb O}_x$. Vanadinbleierz.

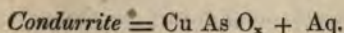
BB, communicate to borax an emerald-green colour: soluble in nitric acid. The solution of *Vauquelinite* is green, that of *Vanadate of Lead* yellow; the former gives, with nitrate of silver, no precipitate, the latter gives a copious precipitate of chloride of silver. The fused bead of *Vauquelinite*, when moistened with muriatic acid, communicates to the blowpipe flame a beautiful blue colour. The colour of *Vauquelinite* is blackish-green, olive-green; that of *Vanadate of Lead* brown and yellowish.

See Aluminate of Lead. (Bleigummi.)

B 3. BB, alone, or with soda, give a bead of Copper. When fused, and then moistened with muriatic acid, they communicate to the blowpipe flame a beautiful but fleeting blue colour, and give, with nitric acid, a sky-blue or green solution, which, on the addition of an excess of caustic ammonia, becomes azure-blue.

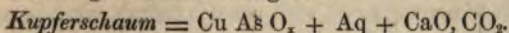
The compounds of copper belonging to this section, are mostly decomposed when boiled with caustic potash, when their acids unite to the alkali. They fall into two groups, viz.: arsenical and non-arsenical. *

a.) BB, exhale a strong odour of arsenic. The majority afford, when heated by themselves, a brittle white metallic button of arseniuret of copper.

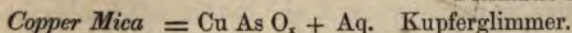


BB in the bulb tube, gives a sublimate of arsenious acid, which is not the case with the minerals that follow. Colour brownish-black.

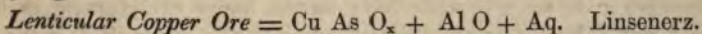
Olivenite = $\text{Cu As P O}_x + \text{Aq.}$ Right Prismatic Arseniate of Cop. BB, fused in the forceps, it crystallises on cooling as a radiated mass of a blackish colour, the surface of which is covered with a net-work of prismatic crystals. It gives only a little water in the bulb tube. Colour olive-green, dark leek-green.



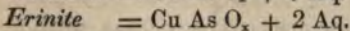
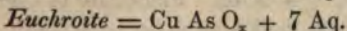
Prismatic Euclore Mica.



BB, decrepitate violently, and give much water in the bulb tube. Both dissolve in ammonia; *Copper Mica* without residue, *Prismatic Euclore Mica* under separation of carbonate of lime. Both are very perfectly cleavable in one direction. The colour of *Prismatic Euclore Mica* is apple-green and verdigris-green; that of *Copper Mica* emerald-green to verdigris-green.



BB, does not decrepitate; on being gently heated it acquires a beautiful smalt-blue colour. Soluble in ammonia, under separation of white flocks. It contains much water, and suffers a loss of 22 per cent. on being heated to redness. Colour sky-blue, sometimes inclining to green.



Distinguished from one another by the different loss of weight which they undergo on being heated to redness. The former loses 18½ per cent., the latter only 5 per cent. of water. Colour of both minerals, emerald-green.

b.) BB, do not exhale an odour of arsenic. The majority afford a malleable button of copper on being heated alone.

Muriate of Copper = $\text{Cu Cl} + 3 \text{CuO} + 4 \text{Aq.}$ Atakamit.

Colours by itself, without being previously moistened with muriatic acid, the blowpipe flame or the flame of a candle beautifully blue, and is thereby easily distinguished from all minerals that resemble it. Colour green, leek-, blackish-, olive-, or emerald-green.

Blue Vitriol = $\text{CuO SO}_3 + 5 \text{Aq.}$ Kupfervitriol.

Brochantite = $\text{Cu}_3\text{O}_3 \text{SO}_3 + 3 \text{Aq.}$

Kupferindig = Cu S.

With soda before the blowpipe give sulphurets, which is not the case with the minerals that follow. *Blue Vitriol* dissolves readily in water; *Brochantite* and *Kupferindig* do not dissolve in water, but dissolve in nitric acid. The solution gives, with nitrate of barytes, a white precipitate of sulphate of barytes. *Kupferindig* burns in the oxidating flame, exhaling the odour of sulphurous acid; *Brochantite* does not show this reaction. The colour of *Kupferindig* is indigo-blue to black; that of *Brochantite* emerald-green.

Red Oxide of Copper = $\text{Cu}_2\text{O.}$ Rothkupfererz.

Black Oxide of Copper = CuO. Kupferschwärze.

Dissolve readily and quietly in acids. The solution of *Red Oxide of Copper* in muriatic acid gives, when diluted with water, a white precipitate (protochloride of copper,) and with caustic potash, gives an ochre-yellow precipitate. The similar solution of *Black Oxide of Copper* gives, with water, no precipitate, and with caustic potash a blueish precipitate. The colour of *Red Oxide of Copper* is cochineal-red; that of *Black Oxide of Copper* brownish or brownish-black. Most specimens of *Black Oxide of Copper* effervesce a little with acids.

Malachite = $\text{Cu}_2\text{O}_2, \text{CO}_2 + \text{Aq.}$

Blue Carbonate of Cop. = $2(\text{CuO}, \text{CO}_2) + \text{CuO}, \text{Aq.}$ Kupferlasur.

Mysorine = $\text{CuO}, \text{CO}_2.$

Dissolve in nitric acid with effervescence, under evolution of carbonic acid gas. *Malachite* and *Blue Carbonate of Copper*, BB, in the bulb tube, give much water; *Mysorine* gives little or none. The colour of *Malachite* is always green; that of *Blue Carbonate of Copper* blue, generally azure-blue; that of *Mysorine* brownish-black.

Libethenite = $\text{Cu}_3\text{O}_4, \text{P}_2\text{O}_5 + 2 \text{Aq.}$ Phosphate of Copper.

Phosphorochalcite = $\text{Cu}_3\text{O}_5, \text{P}_2\text{O}_5 + 5 \text{Aq.}$

Dissolve readily and quietly in nitric acid. The solution, when not too acid, gives, with acetate of lead, a precipitate of phosphate of lead, which fuses before the blowpipe to a polyhedral bead. They are little soluble in ammonia. Colour olive-green to verdigris and blackish-green. *Libethenite* loses, on being heated to redness, 7 per cent. of water; *Phosphorochalcite* loses 14 per cent. of water.

Copper Uranite = $\text{Cu}_3\text{O}_3 \text{P}_2\text{O}_5 + 2(\text{U}_2\text{O}_3 \text{P}_2\text{O}_5) + 24 \text{Aq.}$ Chalkolite. The solution in nitric acid has a yellowish-green colour, and gives, with

caustic ammonia in excess, a blueish-green insoluble precipitate, and a blue liquid. The precipitate afforded by the preceding minerals, when treated with caustic ammonia in excess, is almost entirely re-dissolved. Acetate of lead produces, in the nitric acid solution, a precipitate of phosphate of lead. Colour emerald-green. Very perfectly cleavable in one direction. [There are three cleavages = P,m,t. *Griffin.*]

B 4 BB, *communicate to borax a beautiful sapphire-blue colour. Fused upon charcoal, they exhale a strong odour of arsenic.*

Cobalt Bloom = $\text{Co}_2\text{O}_3, \text{As}_2\text{O}_3 + 6 \text{ Aq.}$ Arseniksaures Kobaltoxyd.

Arsenite of Cobalt = $\text{CoO}, \text{As}_2\text{O}_3 + \text{Aq.}$

Arsenichtsaires Kobaltoxyd.

BB, in the bulb tube, give much water: *Arsenite of Cobalt* gives a sublimate of arsenious acid; *Cobalt Bloom* gives no such sublimate. They both dissolve in muriatic acid, giving a rose-red solution, in which silicate of potash produces a sapphire-blue precipitate. The colour is pink, cochineal-red, peach-blossom, or rose-red.

See Earthy Cobalt.

Nickel Ochre = $\text{Ni}_3\text{O}_3, \text{As}_2\text{O}_3 + 9 \text{ Aq.} (+ \text{Co.})$ Nickelocker.

BB, in the bulb tube, gives much water. The solution in muriatic and nitric acids has a green colour. Caustic ammonia gives a greenish precipitate which dissolves in excess, producing a sapphire-blue solution. Colour apple and sicken-green.

B 5. BB, *when fused in the tongs, or upon charcoal, in the reducing flame, give a black or grey mass, which affects the magnetic needle. Do not show the properties of the minerals that belong to the preceding four sections.*

In order to observe the development of magnetism effectively, it is well to fuse the largest possible quantity of the minerals that are easily fusible, and to keep them exposed for some time to the reducing flame.

This section contains four sub-divisions.

a.) *During fusion, exhale a strong odour of arsenic.*

Pitchy Iron Ore = $\text{Fe}_4\text{O}_6, \text{As}_2\text{O}_3 + 12 \text{ Aq.}$ Eisensinter.

Arseniate of Iron = $\text{Fe}_3\text{O}_3, \text{As}_2\text{O}_3 + \text{Fe}_6\text{O}_9, \text{As}_4\text{O}_{10} + 18 \text{ Aq.}$

Würfelerz. Cube Ore.

Scorodite = $\text{Fe}_2\text{O}_3, \text{As}_2\text{O}_3 + \text{Fe}_4\text{O}_6, \text{As}_4\text{O}_{10} + 12 \text{ Aq.}$

BB, readily fusible to a magnetic bead. The powder is quickly coloured reddish-brown by caustic potash. *Arseniate of Iron* and *Scorodite* occur crystallised; the former in the tesseral, the latter in the

rhombic system. Their colour is generally green of different shades. *Pitchy Iron Ore* is amorphous and opalescent. Colour brownish, blood-red, or white.

b.) *Soluble in muriatic acid, with scarcely any residue, and without forming a jelly.* BB, exhale no odour of arsenic.

Green Copperas = $\text{FeO}, \text{SO}_3 + 6 \text{ Aq.}$ Eisenvitriol.

Red Iron Vitriol = $\text{Fe}_2\text{O}_3, \text{S}_2\text{O}_5 + \text{Fe}_2\text{O}_3, \text{S}_2\text{O}_5 + 36 \text{ Aq.}$ Botryogene. Intumescence strongly before the blowpipe, and fuse imperfectly in the reducing flame to a magnetic slag. They dissolve in water: *Green Copperas* perfectly, *Botryogene* leaving a yellow residue. The solution gives, with chloride of barium, an abundant white precipitate of sulphate of barytes, and with caustic ammonia, a greenish precipitate, which soon becomes brownish-red in the air.

Huraulite = $\text{Mn PO}_x + \text{Fe PO}_x + 30 \text{ Aq.}$

Phosphate of Iron and Manganese.

Heteposite = $\text{Mn PO}_x + \text{Fe PO}_x + 5 \text{ Aq.}$

Triplite = $\text{Mn PO}_x + \text{Fe PO}_x$. Phosphate of Manganese.

BB, fuse readily, and when moistened with sulphuric acid, colour the blowpipe flame light blueish-green. They are dissolved by borax in the oxidating flame to an amethyst-red glass. *Huraulite* gives off in the bulb tube much water, the other two minerals give off only a little water. *Huraulite* is of reddish-yellow colour, not cleavable; *Heteposite* greenish-grey to blueish, cleavable in the direction of a prism of 100° , [= $m_2 \frac{1}{2} t$, *Griffin*.] *Triplite* is brownish-black, cleavable in three directions at right angles to one another [= r,m,t, *Griffin*.]

Triphyline = L Fe Mn P O_x .

BB, acts like the preceding, but does not afford so strong an indication of manganese with borax, but rather a glass coloured with iron. When the solution in muriatic acid is gently evaporated to dryness, then mixed with spirit of wine, and again heated and set on fire, then from time to time, and particularly towards the end of the combustion, we observe purplish-red streaks in the flame. This reaction distinguishes this mineral sufficiently from the similar phosphates of iron. Colour greenish-grey, blueish, &c. Cleavable in four directions.

Vivianite = $\text{Fe}_2\text{O}_3, \text{P}_2\text{O}_5 + 8 \text{ Aq.}$ Phosphate of Iron.

Anglarite = $\text{Fe}_4\text{O}_6, \text{P}_2\text{O}_5 + 4 \text{ Aq.}$

Green Iron-stone = $\text{Fe}_4\text{O}_6, \text{P}_2\text{O}_5 + 2 \frac{1}{2} \text{ Aq.}$

BB, fuse readily, and when moistened with sulphuric acid, act like the preceding. They communicate to borax the colour of oxide of iron only, (in the oxidating flame red, on cooling yellowish, in the reducing flame bottle-green.) In the bulb tube they give much water. *Vivianite* loses, on being heated, 28 per cent., *Anglarite* 16 per cent., and *Green Iron-stone* $8 \frac{1}{2}$ per cent. The colour of *Vivianite* is blue of different shades; that of *Anglarite* grey to blue; that of *Green Iron-stone* leek-green.

See Molybdic Ochre.

c.) *Form a jelly with muriatic acid, or are easily decomposed under separation of silica.*

Cronstedtite = $\text{Mg Mn Fe Si O}_x + \text{Aq.}$ Hydrous Silicate of Iron. BB, in the bulb tube gives much water, and fuses, with slight intumescence, to a black glass. It forms a perfect jelly with muriatic acid. (*Siderochisolite* acts in like manner, and belongs perhaps to the same species.) Colour raven-black, the streak dark leek-green: hardness = $2\frac{1}{2}$.

Lievrite = Ca Fe Si O_x . Fer calcaréo-siliceux.

Allanite = $\text{Ca Ce Al Fe Si O}_x$. Prismatic Cerium Ore.

Both gelatinise completely when treated with muriatic acid. BB, in the bulb tube, they give little or no trace of water. *Allanite* intumescs strongly, and readily fuses to a bulky brownish or blackish mass. Colour brownish or greenish-black; streak greenish-grey; hardness = 6. *Lievrite* intumescs slightly, decrepitates and fuses quietly to an iron-black bead. Colour brownish-black; streak black; hardness = $5\frac{1}{2}$.

Pyrosmalite = $\text{Fe Cl}_x + \text{Fe O}_x \text{ Aq} + x(\text{Mn Fe Si O}_x)$ Fer muriaté. Decomposed by muriatic acid without gelatinising, but under separation of silica. BB, fuses readily = 2. With microcosmic salt and oxide of copper, it communicates a blue colour to the blowpipe flame. Very distinctly cleavable in one direction.

Many varieties of *Eisenkalkgranat* = Ca Fe Si O_x , (*Garnets containing iron and lime*) are likewise almost entirely decomposed by concentrated muriatic acid, forming a gelatinous mass. They are distinguished from the preceding by not forming a perfect jelly, and not being cleavable. [The crystalline system of *Pyrosmalite* is hexagonal, and its cleavage = P. The crystalline system of *Garnet* is octahedral, and its cleavage is commonly indistinct = mt. pm, pt. *Griffin*.]

See Bergholz.

d.) *Very little acted on by muriatic acid.*

Krokydolite = $\text{Na Mg Fe Si O}_x + \text{Aq.}$ Blau-Eisenstein.

Arfvedsonite = Na Fe Si O_x . Variety of Hornblende.

BB, fuse readily = $1\frac{1}{2}$ —2, with strong intumescence and discharge of gas bubbles, producing a black glass. *Arfvedsonite* in the bulb tube, gives much water; it is perfectly cleavable at $123^\circ 50'$, [= $\text{M}_{\frac{1}{9}}^{\frac{1}{9}}\text{T. Griffin}$,] and is of a black colour, with a greyish-green streak. *Krokydolite* in the bulb tube, gives but little water, is of a lavender colour, and is only known to occur in fibrous masses.

See Hornblende.

Green Earth = $\text{K, Mg, Fe, Si, O}_x, \text{Aq.}$ Grünerde. Chlorite?

BB, fuses quietly = 3 without intumescence, and in the bulb tube gives a little water. Colour green; hardness = 1.

Achmite = Na Fe Si O_x .

Hedenbergite = Ca Fe Si O_x . Pyroxène noir.

Fuse quietly, *Achmite* = 2, *Hedenbergite* = $2\frac{1}{2}$, to a black shining glass. Both are cleavable at an angle of nearly 93° . [Cleavage of *Achmite*

= m, T, $m\frac{1}{9}t$; of *Hedenbergite* = $M\frac{2}{1}T$. Griffin.] *Hedenbergite*, after fusion with potash, and precipitation of the muriatic acid solution with caustic ammonia, gives an additional abundant precipitate with oxalate of ammonia. *Achmite*, in like circumstances, gives no precipitate, or only a very slight one.

See Augite.

Garnet = Al Fe Si O_x. Thoneisengranat.

Fuses quietly = 3; not cleavable; hardness = 7 to 7½. Colour red or brownish-red.

See Eisenkalkgranat. See also Epidote, Silicate of Manganese, and Lithia Mica, many varieties of which fuse likewise to a magnetic glass.

B 6. Not belonging to the preceding five Sections.

Molybdic Ochre = Mo O₃. Molybdänocker.

BB, on charcoal, fuses, producing a smoke, and sinking into the pores of the charcoal. When reduced with soda, and then separated from the charcoal by levigation, a steel-grey powder of reduced molybdenum is obtained. With microcosmic salt in the reducing flame, it gives a dark glass, which on cooling becomes clear, and of a beautiful green colour. It dissolves readily in muriatic acid: the solution is colourless, but assumes a blue colour on being stirred with an iron spatula. Colour sulphur-yellow to orange-yellow. [kieselerz.]

Bismuth Blende = 6 Bi Si O_x + Fe Bi P O_x + Bi F. Wismuth-BB, fuses readily to a brown bead. With soda on charcoal it is reduced to a button of bismuth. Forms a perfect jelly with muriatic acid. Colour brown to yellow.

2.) BB, ALONE, OR WITH SODA, ON CHARCOAL, GIVE NO BUTTON OF METAL, AND NO MAGNETIC METALLIC MASS.

See Section 1.) page 18.

B 7. After fusion and strong ignition, on charcoal, in the tongs, or in the platinum spoon, react alkaline, and colour moistened turmeric paper brown.

a.) Easily and entirely soluble in water.

Nitre = KO + N₂O₅. Kalisalpeter.

Nitrate of Soda = NaO + N₂O₅. Natrumsalpeter.

BB, on charcoal, deflagrate strongly, which is not the case with the following minerals of this division. Fused on the platinum wire, *Nitre* colours the blowpipe flame purple, *Nitrate of Soda* colours it yellow. The solution of *Nitre* with chloride of platinum, produces an abundant yellow precipitate, but that of *Nitrate of Soda* produces none.

Soda = $\text{NaO}, \text{CO}_2 + 10 \text{ Aq.}$ Carbonate of Soda.

Trona = $2 \text{ NaO} + 3 \text{ CO}_2 + 4 \text{ Aq.}$ Sesqui-carbonate of Soda.

BB, in the bulb tube, give much water. The aqueous solution reacts alkaline, and effervesces with an acid. The crystals of *Soda* soon effloresce in the air, those of *Trona* do not. [Both colour the flame yellow.]

Glauber's Salt = $\text{NaO}, \text{SO}_3 + 10 \text{ Aq.}$ Glaubersalz.

Thenardite = NaO, SO_3 . Anhydrous Sulphate of Soda.

Sulphate of Potash = KO, SO_3 . Schwefelsaures Kali.

Epsom Salts = $\text{MgO}, \text{SO}_3 + 7 \text{ Aq.}$ Bittersalz.

Potash Alum = $\text{KO}, \text{SO}_3 + 3(\text{AlO}, \text{SO}_3) + 24 \text{ Aq.}$ Kalialaun.

The solution of these salts in water does not react alkaline, and does not effervesce with an acid. Chloride of barium produces an abundant white precipitate, insoluble in acids. *Potash Alum* and *Epsom Salts* in solution, give white precipitates with carbonate of potash. BB, these two are easily distinguished as follows:—A small portion is ignited on charcoal, then moistened with solution of cobalt, and again strongly heated, upon which the *Potash Alum* assumes a beautiful blue colour, and the *Epsom Salts* a pale flesh-red colour. The solutions of the other minerals give no precipitate with alkalis. The concentrated solution of *Sulphate of Potash* is precipitated yellow by chloride of platinum, which produces no precipitate with solution of *Thenardite* or *Glauber's Salt*. *Thenardite* gives no water in the bulb tube, *Glauber's Salt* gives much water. [The two potash salts colour the blowpipe flame violet: the three soda salts colour it yellow.]

Rock Salt = Na Cl. Steinsalz. Chloride of Sodium.

Easily recognised by its taste. The solution in water gives no precipitate with chloride of barium or alkalis, but an abundant precipitate with nitrate of silver. It does not react alkaline.

Tincal = $\text{Na B O}_x + \text{Aq.}$ Crude Borax.

The solution reacts feebly alkaline: it does not effervesce with acids. When treated with sulphuric acid, and evaporated to dryness, it gives a mass which communicates to spirits of wine the property of burning with a green flame.

b.) *Nearly or entirely insoluble in water.*

Gay-Lussite = $\text{CaO}, \text{CO}_2 + \text{NaO}, \text{CO}_2 + 6 \text{ Aq.}$

Carbonate of Lime and Soda.

Witherite = $\text{BaO} + \text{CO}_2$. Carbonate of Barytes.

Dissolve with effervescence in dilute muriatic acid. The much diluted acid solution of *Gay-Lussite* gives no precipitate with sulphuric acid, but that of *Witherite* gives an abundant white precipitate. *Gay-Lussite*, BB, in the bulb tube, gives much water; *Witherite* gives none.

Anhydrite = CaO, SO_3 . Sulphate of Lime.

Gypsum = $\text{CaO}, \text{SO}_3 + 2 \text{ Aq.}$ Hydrous Sulphate of Lime.

Polyhallite = $\text{KO}, \text{SO}_3 + \text{MgO}, \text{SO}_3 + 2 \text{ CaO}, \text{SO}_3 + 2 \text{ Aq.}$

Glauberite = $\text{NaO}, \text{SO}_3 + \text{CaO}, \text{SO}_3$. Brongniartine.

Dissolve quietly in a pretty large quantity of muriatic acid. The solution gives, with chloride of barium, an abundant white precipitate of sulphate of barytes. *Gypsum*, BB, in the bulb tube, gives much water, *Polyhallite* gives little, and the rest only traces. *Polyhallite* and *Glauberite* are dissolved by water under separation of sulphate of lime. The solution of *Polyhallite* gives, with chloride of platinum, a yellow precipitate, *Glauberite* gives none. The fusibility of *Polyhallite* is = 1½. *Anhydrite* and *Gypsum* are sparingly soluble in water. Their fusibility is = 2½ to 3. The hardness of *Anhydrite* is = 3½; all the rest are softer.

Heavy Spar = BaO, SO₃. Sulphate of Barytes. Baryt.

Celestine = SrO, SO₃. Sulphate of Strontian.

Not acted on by muriatic acid; BB, fused with soda, they give sulphurets. When *Heavy Spar* is fused in the tongs it communicates to the flame a pale yellowish-green colour, while *Celestine* gives a faint-purplish colour. When pieces of *Celestine* are held for some time in the reducing flame, and are then moistened with a drop of muriatic acid, and held to the blue part of a candle flame, they colour the flame beautifully purple. This is not the case with *Heavy Spar*.

Fluor Spar = Ca Fl. Fluss. Fluoride of Calcium.

Cryolite = 3 Na Fl + Al Fl₃. Kryolith.

Pharmacolite = Ca₂O₂, As₂O₅ + 6 Aq. Arseniate of Lime.

BB, fused with soda, give no sulphurets, and do not effervesce with muriatic acid. *Pharmacolite* is easily distinguished from the others, by the arsenical odour which it exhales when fused upon charcoal in the reducing flame. (To test this, as large pieces as possible should be used.) *Fluor Spar* and *Cryolite* heated with sulphuric acid in a glass tube evolve much hydrofluoric acid gas, which is known by its acting on the glass. The fusibility of *Cryolite* is = 1, that of *Fluor Spar* = 3.

B 8. Soluble in muriatic acid, and some of them in water, without leaving a residuum, and without producing a jelly.

Ammoniacal Alum = Ammoniakalaun.

Sulphate of Zinc = ZnO, SO₃ + 7 Aq. Zinkvitriol.

Both melt on the first application of heat, and then swell up to an infusible mass, which, moistened with solution of cobalt, and ignited, assumes with *Alum* a beautiful blue colour, and with *Sulphate of Zinc*, a green colour. Both give sulphurets with soda; both are soluble in water. *Ammoniacal Alum* evolves an ammoniacal odour when heated with a solution of caustic potash.

Boracic Acid = B₂O₃ + 6 Aq. Borsäure.

Boracite = Mg₂O₂ B₂O₆. Borate of Magnesia.

Hydroboracite = Ca Mg B O₃ + Aq. Borate of Lime and Magnesia.

BB, fuse readily, intumescing and colouring the flame green. If powdered, moistened with sulphuric acid and heated, and then mixed with

spirits of wine, the latter burns upon them with a green flame. This does not occur with the minerals that follow. *Boracite*, BB, in the bulb tube, gives no water or only traces; the others give much water. *Boracic Acid* is soluble in water and alcohol, the others are soluble in neither.

See Tincal.

Wagnerite = $Mg F_2 + Mg_3 O_3, P_2 O_5$. Fluophosphate of Magnesia.

Apatite = $3 Ca_3 O_3, P_2 O_5 + Ca Cl F$. Phosphate of Lime.

BB, fuse difficultly = $4\frac{1}{2}$, and, moistened with sulphuric acid, tinge the flame transiently blueish-green. The solutions of both in nitric acid give, with acetate of lead, an abundant precipitate of phosphate of lead, which fuses before the blowpipe to a polyhedral bead. *Wagnerite* is also soluble in diluted sulphuric acid; *Apatite* is not.

Amblygonite = $L Al P O_x$. Phosphate of Alumina and Lithia.

BB, fuses very readily = 2. Is difficultly soluble in concentrated muriatic and sulphuric acids. Cleavable at $106^\circ 10'$; [Cleavage = $M\frac{1}{2}T$. *Griffin*.] Hardness = 6.

Uranite = $Ca_3 O_3, P_2 O_5 + 2 U_2 O_3, P_2 O_3 + 24 Aq$. Kalkuranite.

BB, fuses readily; gives much water in the bulb tube; and with microcosmic salt in the oxidating flame, gives a yellow glass, which becomes beautifully green in the reducing flame. The solution in muriatic or nitric acid has a yellow colour, and gives a yellowish precipitate with caustic ammonia.

See Copper Uranite, page 22.

B 9. Soluble in muriatic acid, forming a thick and perfect jelly.

a.) BB, in the bulb tube, give much water.

Natrolite = $Na Al Si O_x Aq$. Natrolith.

Mesole = $Na Ca Al Si O_x Aq$.

BB, fuse quietly = 2, without intumescence or obvious increase in bulk. The solution of *Natrolite* in muriatic acid gives, after the alumina has been precipitated by caustic ammonia, little or no precipitate with carbonate of ammonia; the solution of *Mesole*, on the other hand, then gives a precipitate of carbonate of lime. The loss of weight suffered by *Natrolite*, on being heated to redness, amounts to 9 per cent., that of *Mesole* amounts to 13 per cent.

Scolezite = $Ca Al Si O_x Aq$. Skolezit.

Laumonite = $Ca Al Si O_x Aq$.

BB, bend on fusion with worm-like contortions, particularly *Scolezite*. This mineral gives in the outer flame a bulky, frothy, strongly-illuminating mass, which in the inner flame falls together to a blistered semi-transparent glass. *Laumonite* fuses with evolution of air-bubbles to a white translucent enamel. The hardness of *Scolezite* = $5\frac{1}{2}$, that of *Laumonite* = 3.

The following Zeolitic Minerals approach very nearly to *Scolezite*, and show similar chemical reactions: *Mesolite*, *Thomsonite*, *Comptonite*. [The Kilpatrick *Thomsonite* invariably produces the yellow flame that indicates the presence of soda. *Griffin*.]

Phillipsite = K Ca Al Si O_x Aq. Kalkharmotom. Kaliharmotom. BB, fuses = 3, slightly swelling up, (many varieties fly into smaller pieces like Arragonite.) It has as yet only been found in crystals, which are rectangular prisms, terminated by a rhombic pyramid; it generally occurs in twin-crystals, which cross at an angle of 90°, but have the same perpendicular axis. [Lime.

Datholite = Ca₂O₂, B₂O₃ + 3 CaO, SiO₃ + 2 Aq. Borosilicate of BB, in the bulb tube gives little water, the other minerals of this subdivision give much water; it fuses to a dense, clear, generally colourless glass, and tinges the flame beautifully green. If spirits of wine is burned upon the jelly, the flame is coloured green.

See also in the following section: Apophyllite, Pectolite, Okenite, and Analcime.

b.) BB, in the bulb tube, give no water, or only traces.

See Datholite, in B 9, a).

Häüyne = K Ca Al Si S O_x.

Spinellane = Na Al Si S O_x. Nosin.

Lapis-Lazuli = Na Ca Al Si S O_x. Lasurstein.

Helvine = Be Mn Fe Si O_x.

BB, fused with soda, give sulphurets, which is not the case with the minerals that follow. *Häüyne* and *Spinellane* fuse with difficulty = 4½, *Lapis-Lazuli* fuses readily = 2½ to 3; all three give a white glass. If the solution of *Häüyne* in muriatic acid, after the separation of the silica, be treated first with chloride of barium, and then with carbonate of ammonia in excess, the precipitate thrown upon a filter, and the liquid evaporated, and its solid residue heated to redness, there remains a salt which reacts like chloride of potassium, and the solution of which produces a yellow precipitate with chloride of platinum. If an exactly analogous experiment be made with *Spinellane*, chloride of sodium is obtained, the solution of which gives no precipitate with a solution of platinum. The colour of *Häüyne* is generally sky-blue, that of *Spinellane* grey or brownish, that of *Lapis-Lazuli* azure-blue. *Helvine* is easily distinguished from the three others by its reaction, BB, with borax in the oxidating flame, where it produces an amethyst-red glass.

Sodalite = Na Al Si Cl O_x.

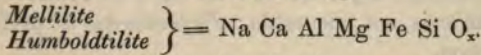
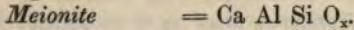
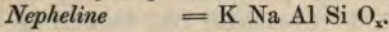
Eudialyte = Na Ca Zr Fe Si Cl O_x.

BB, when fused with microcosmic salt and oxide of copper, give an indication of chlorine, by colouring the flame transiently blue. The solution in nitric acid gives, with nitrate of silver, a white precipitate of chloride of silver. *Sodalite* fuses BB, to a clear colourless glass, *Eudialyte* to an opaque pistachio-nut-green coloured glass.

Wollastonite = CaO, SiO₃. Tabular Spar.

BB, fuses quietly to a colourless semitransparent glass. The solution in

muriatic acid, after the separation of the silica, gives little or no precipitate with caustic ammonia; but with carbonate of ammonia it gives an abundant precipitate of carbonate of lime.



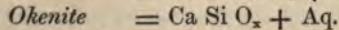
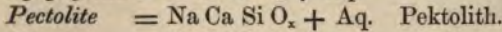
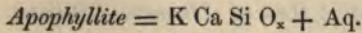
The solution of these minerals gives a precipitate with caustic ammonia. *Meionite*, BB, froths and emits a strong light, and fuses to a blistered glass, which, however, cannot be made quite globular. The others fuse without particular intumescence. *Nepheline* crystallises in regular hexagonal prisms, *Mellilite* and *Humboldtite* in square and octagonal prisms; the last has a distinct basic cleavage [= P. *Griffin*,] but *Mellilite* has no cleavage.

See Gehlenite.

B 10. *Soluble in muriatic acid, leaving a residuum of silica, but without forming a jelly.*

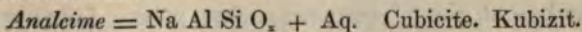
In many cases the substance in fine powder must be treated with concentrated acid.

a.) BB, in the bulb tube, give much water.

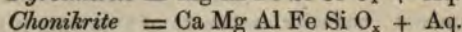
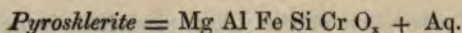


Very readily decomposed by muriatic acid, which separates the silica in gelatinous lumps, without forming a perfect jelly. After the separation of the silica, the solution with excess of acid gives little or no precipitate with caustic ammonia. *Pectolite*, BB, fuses easily, with the evolution of air bubbles, to a white transparent enamelled glass. In the bulb tube it gives only a little water; and after fusion or roasting, forms a jelly with muriatic acid. The others give much water in the bulb tube. They are only difficultly acted on by muriatic acid, after having been previously fused or roasted. *Apophyllite* fuses = 1.5, to a blistered white glass; *Okenite* fuses = 2½ to 3, under frothing, to a porcelainous mass.

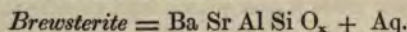
See Meerschäum.



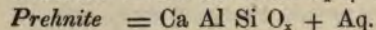
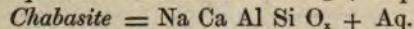
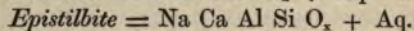
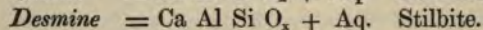
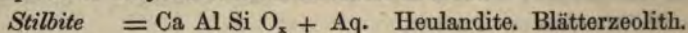
Muriatic acid decomposes it, like the preceding, forming a jelly-like mass. But the solution, after separation of the silica, gives an abundant precipitate with ammonia. BB, on the first application of the flame, it becomes white and opaque, but on the commencement of fusion it becomes as clear as water, and gives, without intumescence, a shining glass. Occurs mostly crystallised in cubes and icositessarahedrons.



Distinguished from the minerals that precede and follow, by their low degree of hardness, which is = 3. *Chonikrite*, BB, fuses = $3\frac{1}{2}$ to 4, with evolution of air bubbles; *Pyrosklerite* fuses = 4, without evolving air bubbles. *Chonikrite* is not cleavable; *Pyrosklerite* is perfectly cleavable in *one* direction.



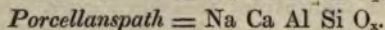
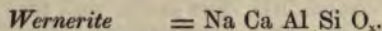
BB, froths, swells up, and fuses = 3. It is easily distinguished from the minerals that most resemble it, by the property, that its diluted solution in muriatic acid gives, with sulphuric acid, a white precipitate of sulphate of barytes, which is insoluble in acids.



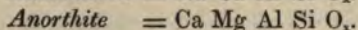
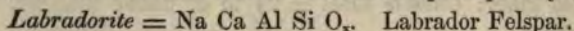
BB, swell more or less strongly, and fuse with contortions to an enamel-like mass. *Phehnite* gives only a little water in the bulb tube, and loses, on ignition, only $4\frac{1}{2}$ per cent. The others give much water in the bulb tube, and lose from 15 to 20 per cent. on being ignited. *Chabasite* is easily distinguished by its rhomboidal crystallisation and imperfect cleavage. *Heulandite*, *Desmine*, and *Epistilbite* are very perfectly cleavable in *one* direction. The crystallographic system of *Stilbite* (*Heulandite*) is oblique prismatic; that of *Desmine* (*Stilbite*), and *Epistilbite*, prismatic.

b.) BB, in the bulb tube, give no water, or only traces.

See B 10, a.) Pectolite, Chonikrite, and Phehnite.



BB, fuse at first = $2\frac{1}{2}$, frothing and emitting a strong light, then give a white blistered glass, which cannot be completely fused to a globular form. They are pretty distinctly cleavable in two directions, at right angles to one another. These minerals are perhaps only *one* species.



BB, fuse quietly = 3, give a pretty dense clear glass. *Labradorite* is unequally cleavable in two directions, at an angle of 94° ; it shows slight streaks on the perfect cleavage faces, but no streaks on the less perfect faces; frequently it exhibits a play of colours, consisting of blue and green, or red and yellow. *Anorthite* is perfectly cleavable at an angle of $94^\circ 12'$, and it has as yet only been found in crystals as clear as water.

Many varieties of *Thonkalkgranat* = Ca Al Si O_x (*Garnets containing Alumina and Lime*) are almost entirely decomposed by concentrated muriatic acid. BB, they fuse = 3, quietly, and are easily distinguished from the preceding by not being cleavable.

See Spheue, which also is almost entirely decomposed by muriatic acid.

B 11. *Very little acted on by muriatic acid; BB, communicate to borax the violet colour that indicates manganese.*

Carpholite = $\text{Al Mn Fe Si Fl O}_x$ Aq. Karpholith.

BB, in the bulb tube gives a considerable quantity of water, which is acid, and corrodes the glass. The minerals that follow in this section, give no water. It has as yet only been found in finely fibrous masses of a straw-yellow colour.

Manganesian Garnet = Al Mn Si O_x . Thonmanganganat.

BB, fuses quietly = 3. Not cleavable. Colour brownish-red.

Mangan-Epidote = $\text{Ca Al Mn Fe Si O}_x$.

BB, effervesces, and fuses = 2 to $2\frac{1}{2}$. Distinctly cleavable in one direction, less distinctly in a second. [Cleavage = $M. \frac{1}{2} P \frac{1}{2} M Zn$. *Griffin*.] Colour cherry-red to reddish-black.

Red Silicate of Manganese = Mn Si O_x . Rother Mangankiesel.

BB, fuses quietly = 3. Distinctly cleavable at $92^\circ 55'$ [= $M \frac{1}{2} O T$. *Griffin*.] Colour rose-red, peach-blossom-red.

B 12. *Not included in the last five sections, and, with the exception of Tungstate of Lime (Scheelite), consist of Siliceous minerals, which are either not at all, or only imperfectly, decomposable by muriatic acid.*

Tungstate of Lime = CaO, WO_3 . Scheelite.

BB, fuses with difficulty = 5. The powder dissolves in muriatic and nitric acids, leaving behind a greenish or lemon-yellow powder (tungstic acid). The residue, while still moist, being rubbed with an iron spatula upon paper, assumes instantly a green or blueish-green colour, and is easily soluble in caustic ammonia.

Lithia-Mica = K L Al Si F O_x . Lithionglimmer.

Petalite = L Al Si O_x . Petalith.

Spodumene = L Al Si O_x . Triphane.

BB, communicate to the flame a transient purple colour. With *Lithia-Mica* it is very distinct, but fainter with the others; it becomes very obvious, however, when the minerals are held in the tongs and fused with bisulphate of potash; this operation being repeated several times, and the assay moved backwards and forwards in the flame during the blowing, purplish-red streaks are then occasionally observed fitting in



the flame. The fusibility of *Lithia-Mica* is = 2, that of the others = $3\frac{1}{2}$. *Spodumene* intumescs a little, and throws out fine ramifications, which quickly fuse to a clear or white glass. *Petalite* fuses quietly to a white enamel.

Barytes Harmotome = Ba Al Si O_x + Aq. Barytharmotom.

Distinguished from the minerals that precede and follow, by giving, BB, in the bulb tube, a considerable quantity of water, and by the circumstance that its partial solution in muriatic acid gives a precipitate of sulphate of barytes with sulphuric acid. Like *Phillipsite*, (*Potash Harmotome*, page 30), it generally occurs in twin crystals.

Axinite = Ca Al Mn Fe Si B O_x.

Tourmaline = K Na L Al Fe Si B O_x.

BB, fused with a mixture of fluorspar and bisulphate of potash, they communicate to the flame a transient green colour.* *Axinite* fuses readily, with much intumescence, to a glistening dark-green glass. The fine powder of melted *Axinite* gelatinises with muriatic acid. The different varieties (species?) of *Tourmaline* act differently. Some of them fuse readily, with intumescence and occasional contortions, to a white, sometimes greenish-grey, and seldom a black glass. Other varieties are difficultly fusible, and a few (*Lithia Tourmalines*) are infusible. Most specimens of *Tourmaline* become strongly electric on being heated.

Diopside = Ca Mg Si O_x.

Augite = Ca Mg Fe Si O_x.

Their hardness is = 6. BB, they fuse = $3\frac{1}{2}$ to 4, sometimes quietly, sometimes with evolution of air bubbles: *Diopside* to a whitish, *Augite* to a black glass. Both are distinctly cleavable at an angle of 93°, [= $M\frac{2}{1}T$ or $M\frac{2}{0}T$. *Griffin*.] *Diopside* is colourless, or light greenish and greyish; *Augite* is black or dark green.

Tremolite = Ca Mg Si O_x. Grammatit.

Hornblende = Ca Mg Fe Si O_x. Amphibole. Strahlstein.

Their hardness is = $5\frac{1}{2}$. They fuse = 3 to 4, with swelling and boiling, *Tremolite* to a white or slightly coloured, and *Hornblende* to a black or greyish glass. Both are distinctly cleavable at an angle of 124 $\frac{1}{2}$ ° [= $M\frac{1}{0}T$. *Griffin*.] *Tremolite* is colourless, or has a greenish or greyish tinge; *Hornblende* is green or black.

Asbestos and *Amianthus* are related to these minerals.

* The colour is most distinctly seen when the mixed flux of fluorspar and bisulphate of potash is fused on the platinum wire, and a little of the mineral in the state of fine powder is then strewed on the surface of the melted flux. A good and clear flame is necessary. The colour is observed at the moment when the mineral begins to fuse with the flux. When the fine powder of *Axinite* or *Tourmaline* that has been fused is digested with sulphuric acid, and then evaporated to the consistence of syrup, and spirits of wine is burned over it, a green colour is communicated to the flame.

[A great many original experiments on the "production of coloured flames" by different substances before the blowpipe, are given in the article, "ANALYSIS BY THE BLOWPIPE," contained in the eighth edition of GRIFFIN'S "Chemical Recreations," 12mo, page 148.]

Sphene = Ca Si Ti O_x. Titanite.

Hardness = 5½. BB, intumescs a little, and fuses = 3 to a blackish glass. It is imperfectly soluble in microcosmic salt, and added in sufficient quantity, it gives, after long continued roasting in the reducing flame, a pale reddish-violet glass. The powder is almost entirely decomposed by concentrated muriatic acid, under separation of silica containing titanate acid. It possesses an imperfect cleavage at an angle of 133½°. [Cleavage = M²T. ½P¹½M Zn. *Griffin*.]

Albite = Na Al Si O_x = Na Si³ + 3 A Si³. Soda Felspar.

Orthoklas = K Al Si O_x = K Si³ + 3 A Si³. Potash Felspar.

Hardness between apatite and quartz = 6. BB, they fuse quietly, *Felspar* = 5, *Albite* = 4. They are not acted on by acids. *Felspar* is distinctly cleavable in two directions, at right angles to each other, [= T. ½P²½M Zn. *Griffin*.] *Albite* in two directions at 93½° [= Te on ½P_xM_xT_xZ³s³e; but there is another cleavage = ½M²T ne sw. *Griffin*.]

Zoisite = Ca Al Si O_x = C Si + 2 A Si.

Epidote = Ca Al Fe Si O_x. Pistazit.

Their hardness is = 6½. BB, they swell and froth, fusing = 3 to 3½, to a blistered cauliflower-like mass, or slag, which is white or yellowish with *Zoisite*, and black or dark brown with *Epidote*. After fusion, they gelatinise with muriatic acid. The colour of *Zoisite* is grey, yellowish-grey, greyish-white; that of *Epidote* is green. *Zoisite* is readily cleavable in one direction; *Epidote* is pretty distinctly cleavable in two directions, at an angle of 115° [= M. ½P¹½M Zn. *Griffin*.]

Thonkalkgranat = Ca Al Si O_x = C Si + A Si.

Garnet containing Lime and Alumina.


Vesuvian = Ca Al Fe Si O_x. Idocrase.

Pyrope = Ca Al Mg Fe Si Cr O_x. Bohemian Garnet.

Hardness = 6½ to 7½. *Thonkalkgranat* and *Vesuvian* fuse = 3, the former quietly, the latter with intumescence; *Pyrope* fuses = 3½. *Vesuvian* is cleavable in the direction of the faces of a quadratic prism, [= p,m,t, mt. *Griffin*.] *Thonkalkgranat* and *Pyrope* are not cleavable. *Thonkalkgranat* is partially acted on by concentrated muriatic acid; its colours are green, yellowish, brown, hyacinth-red, and white. *Pyrope* is not acted on by acids, and has as yet only been found of a blood-red colour.

See in the following order: Emerald, Euclase, Cordierite, and One and Two-axed Mica.

includes a found accompanying quartz, felspar
 & minerals formed by slow
 lying —
 etc with
 minerals formed by rapid cooling —
 Olivine, mica



C. INFUSIBLE, OR FUSIBILITY ABOVE 5.

C 1. *Previously ignited, BB, then moistened with solution of cobalt and again heated, acquire a beautiful blue colour.*

The colour is most distinctly produced by the harder anhydrous minerals which belong to this section, when they are first reduced to a fine powder, and this is moistened and ignited with solution of cobalt. The colour appears to most advantage when the bead is cold, and can only be distinctly observed by day-light.

a.) *BB, in the bulb tube, give much water.*

Alum-stone = $K Al SO_x Aq.$ Alunite.

Aluminite = $Al_2 O_3, SO_3 + 9 Aq.$ Subsulphate of Alumina.

BB, with soda upon charcoal, give sulphurets, which is not the case with the minerals that follow. *Aluminite* dissolves easily in muriatic acid, but *Alum-stone* is not apparently acted on. When *Alum-stone* is ignited and treated with water, alum dissolves out, and may be crystallised in octahedrons by gently evaporating the solution.

See Potash Alum and Ammoniacal Alum.

Aluminate of Lead = $PbO, 2 Al_2 O_3 + 6 Aq.$ Bleigummi.

BB, swells and softens in a strong heat, but does not come to perfect fusion. With soda upon charcoal, gives metallic lead.

Wavellite = $4 Al_2 O_3 + 3 P_2 O_5 + 18 Aq.$ Phosphate of Alumina.

Gibbsite = $Al_2 O_3 + 3 Aq.$

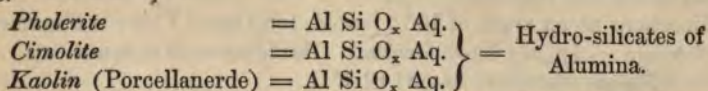
Diaspore = $Al_2 O_3 + Aq.$

Their hardness is considerably greater than that of the minerals that follow, namely, $3\frac{1}{2}$ to $5\frac{1}{2}$. BB, they dissolve in microcosmic salt without residue. *Wavellite* colours the flame faintly but distinctly blueish-green, particularly after being moistened with sulphuric acid, and it dissolves in muriatic acid without gelatinising. It also dissolves in caustic potash. The other minerals do not colour the flame. *Diaspore* is not soluble in muriatic acid; it loses $14\frac{1}{2}$ per cent. by ignition. Many varieties decrepitate violently when heated, BB, in the bulb tube. *Gibbsite* is acted on by muriatic acid; it loses, by ignition, $34\frac{1}{2}$ per cent. water. These minerals generally occur in fibrous or striated masses.

Allophane = $Al Si O_x + Aq.$
Halloysite = $Al Si O_x + Aq.$
Ochran = $Al Si O_x + Aq.$
Kollyrite = $Al Si O_x + Aq.$ } Hydro-silicates of Alumina.

Decomposed by muriatic acid, under separation of silica in the state of jelly. The hardness of *Allophane* is = 3; it gelatinises perfectly, generally colours the blowpipe flame green, from accidentally containing copper, and loses, on ignition, 42 per cent. of water. The hardness of the others is 1 to 2. The loss weight on ignition amounts, with

Halloysite to 16 per cent., with *Ochran* to 21 per cent., and with *Kolyrite* to $33\frac{1}{2}$ per cent. *Ochran* is nearly related to *Lithomarge* and *Bole*.

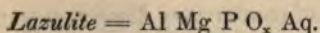


Difficultly acted on by muriatic acid. *Pholerite*, with water, forms a pasty mass, which the others do not. *Kaolin* feels soft to the touch, yet somewhat rough and not greasy. It is decomposed by sulphuric acid. *Cimolite* is soft, may be cut into chips, and is only imperfectly decomposed by sulphuric acid.

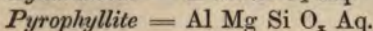
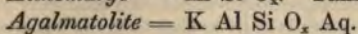
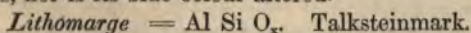
Many sorts of *Clay* with which we are not yet sufficiently acquainted, act in like manner; forming, with water, a pasty mass.

See further on: *Lazulite*, *Pyrophyllite*, and *Agalmatolite*, which likewise give water, but only a little, in the bulb tube.

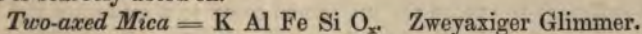
b.) BB, in the bulb tube, give little or no water.



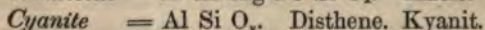
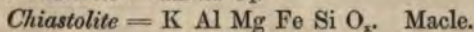
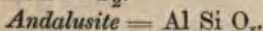
BB, colours the flame faintly greenish when alone, but more distinctly when it has been previously moistened with sulphuric acid; intumesces and falls into little pieces. While undergoing these changes, it loses its blue colour, and becomes white. It is not immediately acted on by acids, nor is its blue colour altered.



Possess a low degree of hardness = 1 to 2. *Pyrophyllite* is very perfectly cleavable in *one* direction. BB, it intumesces to a very bulky fan-shaped mass. The others are not cleavable, and do not alter before the blowpipe. *Lithomarge* is partially decomposed by acids; *Agalmatolite* is scarcely acted on.



Cleavable in the highest degree in *one* direction. [Crystalline form = T, $M\frac{1}{2}$ T, $\frac{1}{2}P\frac{5}{17}M$ Zn; Cleavage = $\frac{1}{2}P\frac{5}{17}M$ Zn. *Griffin*.] BB, it intumesces a very little; in very thin films it fuses. The blue colour produced by solution of cobalt is in patches. Not acted on by acids. Hardness = $2\frac{1}{2}$.



Slightly acted on by acids. BB, they are decomposed by microcosmic salt, and separate a skeleton of silica. *Andalusite* and *Chiastolite* are pretty distinctly cleavable in two directions, at an angle of $91\frac{1}{2}^\circ$, [= $m\frac{28}{100}t$. *Griffin*.] They are easily distinguished from one another by their hardness; that of *Andalusite* being = $7\frac{1}{2}$, that of *Chiastolite* 5 to $5\frac{1}{2}$. The latter mineral generally occurs in the form of four pris-

matic crystals, so united together parallel with their chief axis, as to leave an empty space between them, which is generally filled up with dark-coloured clay-slate. *Cyanite* is very distinctly cleavable in two directions at an angle of 106° , [= M, $\frac{1}{2}m\frac{1}{2}t$ nw. There is also another cleavage = $\frac{1}{2}p_m, t$ Znw. *Griffin*.] Hardness = 6 or less.

Topaz = Al Si F O_x.

Lithia-Tourmaline = K L Al Mn Si B O_x. Lithionturmalin.

Not acted on by acids. BB, do not perfectly dissolve in microcosmic salt: the bead becomes opaque on cooling. *Topaz* retains its transparency during ignition, and does not intumescence. *Lithia-Tourmaline* becomes white and intumescence, often producing a slag. *Topaz* is distinctly cleavable in *one* direction [= P. It has also several indistinct cleavages = $x m_x, t$. *Griffin*;) and its hardness is = 8. *Lithia-Tourmaline* is not cleavable, and its hardness is = $6\frac{1}{2}$. The *Tourmaline* becomes pretty strongly electric on being heated, which is the case only with some varieties of *Topaz*.

Corundum = Al₂O₃. Sapphire.

Chrysoberyl = Al Be Si O_x. Cymophane.

Not acted on by acids. In the state of powder they dissolve slowly but perfectly in microcosmic salt before the blowpipe, and the glass does not become opaque on cooling. The hardness of *Sapphire* is = 9, that of *Chrysoberyl* is = $8\frac{1}{2}$. The specific gravity of the former is = 4, that of the latter is = 3.7.

Many specimens of Spinell and Leucite, when in fine powder and moistened with solution of cobalt, become blue, on ignition.

The blue afforded by finely pulverised Quartz, when moistened with solution of cobalt, is distinguished from that of the preceding minerals by its reddish tinge and less intensity.

C 2. *Moistened with solution of cobalt and ignited, BB, assume a green colour.*

It is sufficient to expose the moistened assay to a moderate red heat.

The compounds belonging to this section contain Zinc, which coats the charcoal with a sublimate that has a yellow colour when hot, but becomes nearly white when cold.

Calamine = Zn O + C O₂. Zinkspath. Carbonate of Zinc.

Zinkblüthe = Zn O + C O₂ + x Aq. Basic Carbonate of Zinc.

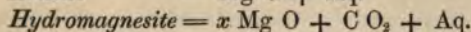
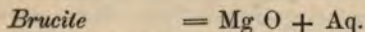
Dissolve readily, with effervescence, in muriatic acid. The solution gives, with caustic ammonia, a precipitate soluble in excess. *Calamine*, BB, in the bulb tube, gives little or no water. *Zinkblüthe* gives much water.

Willelmine = Zn Si O_x. Anhydrous Silicate of Zinc.

Siliceous Oxide of Zinc = Zn Si O_x + Aq. Electric Calamine.

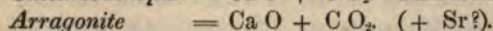
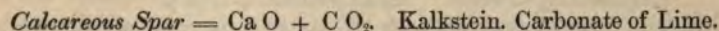
Gelatinise perfectly with muriatic acid. The latter gives water in the bulb tube; the former gives none.

C 3. After ignition, BB, react alkaline, and turn moistened turmeric paper brown.

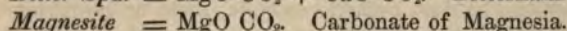
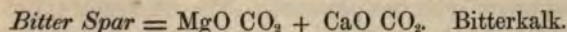


Basic Carbonate of Magnesia.

BB, in the bulb tube, give much water, which is not the case with the minerals that follow. *Brucite* dissolves readily and quietly in muriatic acid; *Hydromagnesite* dissolves with effervescence.

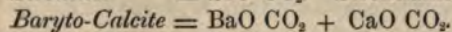
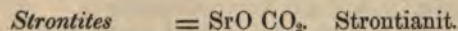


Both effervesce strongly when moistened with muriatic acid, and large lumps of them may thus be dissolved without the aid of heat. The concentrated solution gives a precipitate of sulphate of lime with sulphuric acid; the diluted solution, however, affords no precipitate with that reagent. *Arragonite*, BB, cracks and falls into pieces; *Calcareous Spar* often decrepitates, but does not crumble like *Arragonite*.



Do not effervesce when moistened with sulphuric acid, or even when in powder, only partially. On the application of heat, they dissolve with effervescence. The concentrated solution of *Bitter Spar* gives, with sulphuric acid, a precipitate of sulphate of lime; that of *Magnesite* gives no precipitate. *Magnesite* dissolves perfectly, or nearly so, in sulphuric acid. *Bitter Spar* is only partly soluble in that acid.

Brown Spar (Braunspath) resembles Bitter Spar in its chemical reactions, but becomes black, and generally somewhat magnetic, on ignition.



Dissolve in diluted muriatic acid, with effervescence. The much diluted solution affords, with sulphuric acid, a white precipitate. *Strontites*, before a strong blowpipe flame, throws out little branches, which shine with a resplendent white light, and colour the flame beautifully red; *Baryto-Calcite*, on the contrary, tinges the flame faint yellowish-green, and the assay assumes a green colour.

See Carbonate of Manganese and Carbonate of Iron, which sometimes react Alkaline after ignition. See also Yttrocerite.

C 4. *Perfectly, or for the most part, soluble in muriatic or nitric acid, without forming a jelly, or leaving any considerable residuum of silica.*

Carbonate of Iron = FeO CO_2 . Eisenspath. Sparry Iron Ore.

Junkerite = FeO CO_2 .

Mesitinspar = Mg Mn Fe C O_2 .

Carbonate of Manganese = MnO CO_2 . Manganspath.

Carbonate of Cerium = $\text{Ce}_2\text{O}_3\text{CO}_2 + 2 \text{Aq.}$

Dissolve in muriatic acid, with the aid of heat, evolving carbonic acid gas. The minerals that follow do not effervesce. *Carbonate of Iron* and *Mesitinspar* burn before the blowpipe, and immediately become black, and attractable by the magnet. Most varieties of *Carbonate of Iron* decrepitate very strongly before the blowpipe. It communicates to borax a bottle-green colour. The solution of *Mesitinspar* in nitric acid, after the precipitation of the oxide of iron by caustic ammonia, affords no precipitate with oxalate of ammonia, but an abundant precipitate with phosphate of soda and ammonia. The solution of *Carbonate of Iron* gives, with the last named reagents, little or no precipitate. *Junkerite* = Fe O CO_2 , behaves like *Carbonate of Iron*, but is distinguished by being cleavable in the direction of the faces of a rhombic prism of $108^\circ 26'$ [= M $\frac{1}{2}$ T. Griffin.] *Carbonate of Manganese*, BB, turns grey or black, and frequently becomes magnetic. It communicates to borax an amethyst-red colour in the oxidating flame. *Carbonate of Cerium*, in the bulb tube, gives much water, and becomes brownish-yellow in the blowpipe flame. It communicates to borax, in the oxidating flame, a red or dark-yellow colour, which becomes paler on cooling.

Göthite = $\text{Fe}_2\text{O}_3 + \text{Aq.}$ Rubin-Glimmer.

Eisenoxyd-Hydrat. Hydrous Oxide of Iron.

Brown Iron Ore = $\text{Fe}_4\text{O}_6 + 3 \text{Aq.}$ Brauneisenerz.

BB, in the reducing flame, become black and magnetic: they give much water in the bulb tube. They dissolve slowly, and without effervescence, in muriatic acid. The solution affords a brown-red precipitate with caustic ammonia. *Göthite* occurs crystallised, and is distinctly cleavable in *one* direction; its colour is hyacinth-red, brown, and blackish-brown; it loses 10 per cent. on ignition. *Brown Iron Ore* occurs in fibrous, and likewise compact masses, and loses, on ignition, $14\frac{1}{2}$ per cent. The colour of the streak of both is ochre-yellow.

See Red Iron Ore.

The *Hydrous Oxide of Iron*, which occurs in the form of Iron Pyrites, agrees in its chemical constitution with Göthite. *Yellow Clay Iron-stone*, *Pea Iron Ore*, *Bog Iron Ore*, &c., are mixtures of Brown Iron Ore, clay, sand, phosphate of lime, peroxide of iron, &c. They are generally fusible, often very readily so, and are dissolved by muriatic acid under separation of clay, &c.

Calait = $\text{Al Cu P O}_x \text{ Aq}$. Turquoise. Kalait.

BB, colours the flame green, and, when moistened with muriatic acid, transiently blue. It dissolves, for the most part, in caustic potash, leaving a brown residue which contains copper. Gives much water in the bulb tube. Colour sky-blue or greenish-blue.

Earthy Cobalt = $\text{Co Mn O}_x + \text{Aq}$. Erdkobalt.

BB, gives, with borax, a beautiful sapphire-blue glass. When heated upon charcoal it generally smells faintly of arsenic. Many specimens of *Earthy Cobalt* are fusible.

Pitch Blende = UO . Uranpecherz.

Uran Ochre = $\text{U}_2\text{O}_3 + x\text{Aq}$. Uranocker.

BB, with microcosmic salt in the oxidating flame give a yellow glass, and in the reducing flame a beautiful green glass. They dissolve in nitric acid, giving a yellow solution, in which caustic ammonia produces a sulphur-yellow precipitate. The colour of *Pitch Blende* is pitch-black. that of *Uran Ochre* yellow. Many specimens of *Impure Uran Ochre* are fusible.

Oxide of Chrome = Ch_2O_3 . Chromocker.

BB, with microcosmic salt, gives an emerald-green glass both in the oxidating and the reducing flame. Dissolves in caustic potash, and forms a green solution, from which it precipitates on being long boiled.

Red Oxide of Zinc = ZnO . Zinkoxyd.

Zinc-Blende = ZnS . Zinkblende. Sulphuret of Zinc.

Marmatite = $\text{FeS} + 3 \text{ZnS}$. Sulphuret of Zinc and Iron.

Red Oxide of Zinc dissolves easily in muriatic acid, without evolution of gas. The solution gives, with caustic ammonia, a white precipitate, which is soluble in excess. Colour aurora-red. Occurs in nature mixed with oxide of manganese, and therefore communicates to borax an amethyst-red colour. *Zinc-Blende* and *Marmatite* are for the most part decomposed by muriatic acid, and evolve sulphuretted hydrogen gas. Concentrated nitric acid dissolves them under separation of sulphur. The solution of pure *Zinc-Blende* gives a precipitate with caustic ammonia, which is either entirely soluble in excess, or leaves behind only a few red flocks of oxide of iron. The solution of *Marmatite* leaves behind a considerable residue of oxide of iron. *Marmatite* is likewise easier decomposed by muriatic acid than is *Zinc-Blende*.

Neutral Fluoride of Cerium = CeF . Fluorcerium.

Protofluoride of Cerium = $\text{Ce}_2\text{F}_3 + \text{Ce}_2\text{O}_3 \text{ Aq}$.

Evolves hydrofluoric acid gas with sulphuric acid. The *Protofluoride of Cerium*, BB, on charcoal, alters its yellow colour, and, when heated nearly to redness, appears black, and becomes on cooling dark-brown, then beautifully-red, and lastly dark-yellow. The *Neutral Fluoride* does not present this series of changes, but only becomes somewhat darker in colour. They both dissolve in borax in the oxidating flame to a red or dark-yellow glass, the colour of which turns paler on cooling, and at last becomes yellow. The glass can be converted into a white enamel by the operation of flaming.

Ytrocrite = Ca Y Ce Fe O₃.

Resembles the above in its properties; it is distinguished by being cleavable in the direction of the planes of a quadratic prism. (Probably reacts alkaline after strong ignition.)

C 5. *Soluble in muriatic acid, either producing a jelly, or else depositing silica without producing a jelly. Do not show the characteristics of the four preceding sections.*

a.) *In the bulb tube, give much water.*

Dioptase = Cu₃O₃ Si₂O₆ + 3 Aq. Emerald Copper.

Chrysocolla = Cu₃O₃ Si₂O₆ + 6 Aq. Kieselmalachit.

BB, with soda, effervesce, and give a glass which encloses a button of malleable copper. *Dioptase* forms, with acids, a perfect jelly; *Chrysocolla* is decomposed without gelatinising.

Thorite = Th₃O₃ SiO₃ + 3 Aq.

Cerite = Ce₃O₃ SiO₃ + 3 Aq.

BB, give no button of copper with soda. They gelatinise with acids. The jelly formed by *Cerite*, with pretty diluted muriatic acid, is somewhat soft; with rather strong muriatic acid, it only affords a jelly-like mass. They dissolve in borax, BB. *Cerite*, in the oxidating flame, gives a dark-yellow glass, which becomes pale on cooling, and may be rendered opaque by flaming. *Thorite* gives a glass coloured by iron, or the glass may be obtained with the amethyst-red colour of manganese, if the development of that colour is promoted by the addition of nitre. This glass cannot be rendered opaque by flaming, but on the addition of a large quantity of the mineral it becomes spontaneously opaque. The specific gravity of both minerals is between 4½ and 5.

Thraulite = Fe₂O₃ SiO₃ + 3 Aq. Hydrous Silicate of Iron?

Mountain Wood = Fe₂O₃ SiO₃ + Mg₃O₃ Si₂O₆ + 5 Aq. Bergholz.

BB, become magnetic after continued roasting or fusion in the reducing flame. Easily decomposed by muriatic acid without forming a perfect jelly. The solution of *Mountain Wood*, after the precipitation of the oxide of iron by caustic ammonia, gives still an abundant precipitate with phosphate of soda and ammonia; the solution of *Thraulite*, treated in like manner, gives no precipitate. *Thraulite* is friable, brittle, and of brownish-black colour. *Mountain Wood* has as yet only been found in fibrous, tough, woodlike masses of a wood-brown colour.

Nontronite = Fe₂O₃ Si₂O₆ + Aq.

Fettbol = Fe₂O₃ Si₃O₉ + 3 Aq.

Behave like *Thraulite*. The colour of *Nontronite* is straw-yellow, that of *Fettbol* liver-brown. The former loses, on ignition, 18½ per cent. of water, the latter 24½ per cent.

Meerscham = MgO Si₃O₉ + Aq. Ecume de mer. Sea-foam.

Serpentine = Mg Fe Si O_x Aq. Ophit.

Schiller Spar = Ca Mg Fe Si O_x + Aq. Diallage metalloïde.

Meerscham, BB, becomes white, and shrinks together; it is readily

decomposed by muriatic acid, affording a jelly-like mass, but not a perfect jelly. Absorbs water greedily. Is very light: specific gravity = $1\frac{1}{2}$. *Serpentine* and *Schiller Spar*, in the state of fine powder only, are perfectly decomposed by concentrated muriatic acid, whereby the silica separates as a slimy residue. *Schiller Spar* is perfectly cleavable in *one* direction, and possesses a pseudo-metallic mother-of-pearl lustre; *Serpentine* is not cleavable, and has only a glimmering greasy lustre.

(b. In the bulb tube, give no water, or only traces.

Gadolinite = Ce Y Fe Si O_x.

Gehlenite = Mg Al Si O_x.

Form a perfect jelly with muriatic acid. *Gadolinite*, BB, intumescs, and many varieties show a peculiar effulgence. Some become rounded on very thin edges. Not cleavable: colour black, blackish-green; specific gravity 4 to $4\frac{1}{3}$. *Gehlenite*, BB, does not intumescs; it becomes rounded on thin edges, without showing any particular effulgence. Is cleavable in *one* direction, but not very distinctly. Colour greyish; specific gravity = 3. The *Compact Gehlenite* from Montzoni fuses much more readily than the crystallised varieties.

Chrysolite = MgO SiO₂. Olivine.

Condroidite = 4 Mg₂O₃ SiO₃ + MgF.

Form a perfect jelly with muriatic acid. *Condroidite* (*Chondroidite*) evolves much hydrofluoric acid gas when treated with sulphuric acid, which *Chrysolite* does not. The hardness of *Chrysolite* is = 7. BB, it is scarcely altered. Colour olive-green.

Leucite = K Al Si O_x. Amphigène. Leuzit.

Decomposed by muriatic acid without forming a jelly; the silica separates in the form of fine powder. Many specimens produce a beautiful blue colour when ignited with solution of cobalt. Occurs almost always crystallised in icositessarahedrons [= 3 P $\frac{1}{2}$ MT. *Griffin*.] Hardness = $5\frac{1}{2}$. Colour greyish, yellowish, white.

C 6. The remaining mineral species, which cannot be brought under the preceding sections, are divided into two groups, according to their hardness.

a.) Hardness under 7, (that of Quartz.)

One-axed Mica = K Mg Al Fe Si O_x. Einaxiger Glimmer.

Chlorite = Mg Al Fe Si O_x + Aq.

Steatite = Mg Si O_x + Aq. Soap-stone. Speckstein.

Talc = Mg Si O_x. Talk.

They are all, with the exception of *Steatite*, very perfectly cleavable in *one* direction; their hardness is = 1 to $2\frac{1}{2}$. *One-axed Mica* and *Chlorite* are perfectly decomposed by concentrated sulphuric acid; the former,

BB, in the bulb tube, gives no water, or only traces, the latter gives a considerable quantity, losing by ignition 12 per cent. The plates of *One-axed Mica* are pretty elastic, while those of *Chlorite* are in general only flexible. *Talc* and *Steatite* are not decomposed by sulphuric acid; their hardness is = 1. *Steatite*, BB, in the bulb tube, gives water; *Talc* gives none, or only traces. *Steatite* is perhaps nothing else than *Compact Talc*.

See *Two-axed Mica*, page 37. This is not decomposed by concentrated sulphuric acid, as is the *One-axed Mica*.

Hypersthene = Ca Mg Fe Si O_x. Diallage. Bronzite.

Anthophyllite = Mg Fe Si O_x.

Hypersthene is perfectly cleavable in *one* direction, and exhibits a splendid pseudo-metallic mother-of-pearl lustre on the fresh cleavage faces; [Query, if not two cleavages = $M\frac{2}{2}O\frac{1}{1}T$? *Griffin*.] *Anthophyllite* is distinctly cleavable in two directions, at an angle of 124° 30' [= $M\frac{1}{1}O\frac{0}{0}T$. *Griffin*.] and exhibits upon these faces a lustre similar to that of *Hypersthene*, but not quite so splendid. Their hardness is = 5 to 5½.

Tungstic Acid = WO₃. Wolframsäure.

Dissolved by caustic potash. The solution gives, with nitric acid, a white precipitate, which assumes a lemon-yellow colour on being boiled. Occurs in soft earthy masses of a yellow colour.

Phosphate of Yttria = Y₃O₃ P₂O₅. Phosphorsaure Yttererde.

BB, moistened with sulphuric acid, colours the flame pale-green; dissolves in microcosmic salt, affording a colourless glass. Hardness = 5.

Tin-Stone = Sn O₂. Zinnstein. Oxide of Tin.

BB, in splinters, on charcoal, in a good reducing flame, it gives metallic tin. It is considerably heavier than any minerals that resemble it; its specific gravity is 6.8 to 7. Hardness = 6½.

Anatase } = Ti O₂. Oxide of Titanium.
Rutile }

BB, in the state of powder with microcosmic salt, dissolve with difficulty, and communicate to the glass in the reducing flame a red colour, which, on the addition of metallic tin, becomes blue or violet. *Anatase*, by itself, generally gives a blue glass. *Anatase* is perfectly cleavable in the direction of the faces of a quadratic pyramid, the angle across whose horizontal edge is 136° 22' [= $P\frac{3}{2}M$, $P\frac{1}{2}T$; also = P. *Griffin*.] *Rutile* is cleavable in the direction of the faces of an equiangular octagonal prism [= m,t,MT. *Griffin*.] The hardness of *Anatase* is = 5½. Colour indigo-blue, brown, seldom red. The hardness of *Rutile* is = 6½. Colour generally red, brownish-red, yellow, blackish. Both possess a splendid pseudo-metallic adamantine lustre.

b.) *Hardness = 7 or above 7.*

Quartz = Si O_3 . Rock Crystal, Amethyst, Hornstone, Flint, &c.

Opal = $\text{Si O}_3 + \text{Aq.}$

BB, on charcoal, with soda, of which too much must not be taken, fuse easily, with effervescence, producing a clear glass. By themselves they are infusible, and unalterable, in the strongest heat that the blowpipe can produce. The hardness of *Quartz* is = 7: its general form is the combination of a regular six-sided pyramid, whose horizontal edge has an angle of $103\frac{1}{2}^\circ$, with the regular six-sided (horizontally-streaked) prism. [= V. 2 $\text{R}\frac{2}{3}$ Zw Ze. *Griffin.*] The hardness of *Opal* is = 6; it is amorphous, and BB, in the bulb tube, it generally gives water.

Dichroite = Mg Al Fe Si O_x . Iolite. Cordierite.

Staurolite = Al Fe Si O_x .

Their hardness is = 7. BB, with soda, they do not afford a clear glass. *Dichroite* fuses = 5 to $5\frac{1}{2}$; its colour is blue, greyish. *Staurolite* is infusible; its colour is brownish-red, brown. [Cleavage of *Staurolite* = T, $\text{m}\frac{9}{17}$ t. Crystals commonly twins = $(\text{P}_+, \text{T}, \text{M}\frac{9}{17}\text{T}) \times 2$. The cleavage and crystals of *Dichroite* are nearly like the six-, and twelve-sided prisms of the hexagonal system. *Griffin.*]

Beryl = $\text{Al Be Si}_x \text{O}_x$. Smaragd. Emerald.

Euclase = Al Be Si O_x . Euklas. Prismatic Emerald.

Phenakite = Be Si O_x .

Zircon = Zr Si O_x .

Their hardness is = 7.5. *Beryl* and *Euclase*, BB, become milk-white in a strong flame, and are rounded on very thin edges. *Beryl* crystallises in regular six-sided prisms, and has a pretty distinct cleavage parallel with the base. [= P. It also cleaves = V. *Griffin.*] *Euclase* crystallises in oblique rhombic prisms, and is perfectly cleavable in two directions, at right angles to one another. [It has also another cleavage, in all = $\text{m}, \text{T}, \frac{1}{2}\text{p}\frac{9}{17}\text{m}$ Zn. *Griffin.*] *Phenakite* and *Zircon*, BB, remain unaltered, except that *Zircon* becomes colourless. Both occur only crystallised, *Phenakite* in regular six-sided prisms, terminated by six-sided and three-sided pyramids; and *Zircon* in square pyramids and square prisms. The specific gravity of *Zircon* is = 4.4 to 4.6, that of the other is = $2\frac{1}{2}$ to 3.

Spinel = $\text{MgO} + \text{Al}_2\text{O}_3$.

Pleonaste = Mg Fe Al O_x . Ceylanite. Zeylanit.

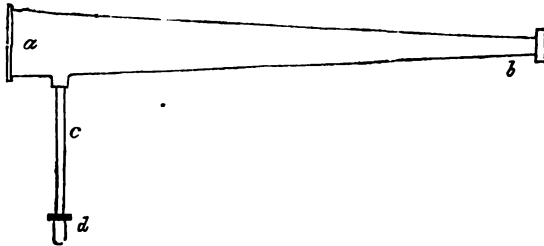
Automalite = Mg Zn Al O_x . Gahnite.

Their hardness is $7\frac{1}{2}$ to 8. They occur almost only crystallised in octahedrons, [or combinations of the octahedral system.] *Spinel* and *Pleonaste*, BB, in the state of powder, with microcosmic salt, dissolve readily and perfectly; the glass does not become opaque on cooling. The colour of *Spinel* is red, blue, brownish; that of *Pleonaste*, black.

Automalite, BB, is almost insoluble in borax and microcosmic salt. In fine powder, with soda, on charcoal, in a good reducing flame, it gives a circular deposit of oxide of zinc, which is yellow when hot, but becomes white on cooling. Colour of *Automalite* dark leek-green to greyish-green.

Diamond = C. Diamant. Demant.

Sufficiently characterised by its hardness, which exceeds that of all other minerals.



INDEX.

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